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Supporting Technology For Advanced Oil Recovery

INFILL PREDICTIVE MODEL

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SECOND AMENDMENT AND EXTENSION TO

Annex III--Evaluation of Past and Ongoing Enhanced Oil Recovery Projects

Implementing Agreement Between

THE DEPARTMENT OF ENERGY OF THE UNITED STATES OF AMERICA

And

THE MINISTRY OF ENERGY AND MINES OF THE REPUBLIC OF VENEZUELA

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FOREWORD

The Infill Drilling Predictive Model (IDPM) is in a style similar to previous Enhanced Oil Recovery Predictive Models which were developed for and in conjunction with the Chemical Task Group of the National Petroleum Council (NPC) for use in the 1982-1984 NPC study on enhanced oil recovery (EOR) potential. The model is designed to conform to the methodology and structure of the suite of models used in that study. This insures that all models calculate and report predicted oil recovery and economics in an identical manner. As do the other models, the IDPM contains an extensive set of default equations to calculate non-critical reservoir properties, flood properties, and economic criteria. The Department of Energy, Bartlesville Project Office, supported the NPC and has maintained the models since the NPC study was completed.

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1.1 INTRODUCTION

Development History and Overview

The Infill Drilling Predictive Model (IDPM) was developed by Scientific Software-Intercomp (SSI) for the Bartlesville Project Office (BPO) of the United States Department of Energy (DOE). The model and certain adaptations thereof were used in conjunction with other models to support the Interstate Oil and Gas Compact Commission's (IOGCC) 1993 state-by-state assessment of the potential domestic reserves achievable through the application of Advanced Secondary Recovery (ASR) and Enhanced Oil Recovery (EOR) techniques. Funding for this study was provided by the DOE/BPO, which additionally provided technical support.

The IDPM is a three-dimensional (stratified, five-spot), two-phase (oil and water) model which uses a minimal amount of reservoir and geologic data to generate production and recovery forecasts for ongoing waterflood and infill drilling projects. The model computes water-oil displacement and oil recovery using finite difference solutions within streamtubes. It calculates the streamtube geometries and uses a two-dimensional reservoir simulation to track fluid movement in each streamtube slice. Thus the model represents a hybrid of streamtube and numerical simulators.

Features of the model include the following:

- Analysis for 5-to-5 and 5-to-9-spot drilldowns.
- Initiation of infill drilling at a user-specified water cut or date.
- Two methods of modelling the increase in continuity due to infill drilling one based on increasing the relative permeability of the reservoir, the second based on adding another layer.
- Output includes a forecast of production complete with project economics.

The architecture of the IDPM follows that of EOR models published in the past by the DOE. For a single pattern, functions for oil and water rate versus time are computed subject to a user-specified ending water cut or date. The functions are passed to an economics routine where they are scaled up for the entire entity (field/reservoir) under consideration. Input data for drilling, completion, injection, and operating costs together with a pattern development schedule allow the computation of before- and after-tax discounted cash flow. Incremental economics are calculated by comparing the infill project to continued waterflood. A logic diagram of the software is shown on Figure 1.1.

Background

Infill drilling of pattern waterfloods has received remarkably little attention from both the public and professional communities. Given the right circumstances, this process can compete favorably with enhanced oil recovery (EOR) processes on a recovery basis for much less investment and operating cost. And yet it appears that there are no research institute programs, university projects, government programs or tax incentives to encourage the development and application of infill drilling. There is virtually no technical literature on the subject, as compared to EOR, and until recently there was very little field data to support or deny any claim concerning the benefits of infill drilling.

Over a decade ago, van Everdingen (van Everdingen, 1980) provided our industry with yet another service by raising a controversy around infill drilling. His statement that, "Infill drilling, if done properly, can be used to recover at least as much oil as the U.S. already has produced," (120 billion bbl) created a controversy that still goes on today. Although this statement may be exaggerated for the U.S. as a whole, it is interesting to note that until the IOGCC study, no comprehensive analysis had been conducted to determine just how much could be recovered. As a result of his original position papers, van Everdingen was asked by the DOE to investigate the subject further. His resulting proof was inconclusive, primarily due to a lack of good field data and reservoir description.

Holm (Holm, 1980) provided a thought-provoking discussion of van Everdingen's work, but his analysis was limited by the same lack of field data. At that time there was very little technical analysis of infill drilling as an incremental recovery process. Holm's estimate of the potential of infill drilling was much more conservative, "with our best efforts we could add to U.S. reserves about 1 to 1.5 billion bbl/yr for about 10 years." Holm's estimated national average was 34 to 47 mbbl per infill well. In our current times of reduced reserve additions from exploration, such additions would be most welcome.

A very significant paper by Barber, et. al. (Barber, 1983) confirmed Driscoll's (Driscoll, 1974) observations of 2 to 8 percent incremental recovery from infill drilling. Barber analyzed nine sets of field data showing very positive incremental recovery due to infill drilling. Two of the reservoirs, Dorward and Sand Hills, were primary projects and thus cannot be used for comparison with secondary pattern floods. The Howard-Glassock reservoir is a peripheral flood and as such is also not directly comparable. Data from Barber, Driscoll, and Ghauri (Ghauri, 1980) are summarized in Table 1-1 for a total of 1323 wells with an average incremental recovery of 107.1 mbbl per infill well. This average is greater than Holm's by a factor of 2 to 3, but is weighted specifically for West Texas carbonates.

If Holm's more conservative estimate is correct, 10 to 15 billion bbls is still a very large number for a virtually unstudied incremental recovery process. This represents 2 to 3 percent of the national "original oil in place" of 460 billion bbls. Current field data for a limited number of projects shows estimated infill recoveries of about 5 percent OOIP. Although the true benefit of infill drilling is unknown, its potential is well established.

The National Petroleum Council (NPC) published a study on EOR potential in the U.S. (NPC, 1984) which concluded that, "as much as 14.5 billion bbl of additional oil could ultimately be recovered with the successful application of existing EOR technology, under current economic conditions." NPC's conclusion assumes a 30 $/bbl nominal crude price and 10% minimum discounted cash flow rate of return (DCFROR). At 20 $/bbl, the projection is as follows:

EOR Process	**Additional Recovery**
Thermal	4.4
Miscible	2.0
Chemical	1.0
Total	7.4 Billion bbl

Thus, while there is significant upside potential due to technical improvements, at 20 $/bbl, there is insufficient incentive to develop it. With crude prices at 20 $/bbl and below, infill drilling would appear to have equal or greater potential than EOR processes.

The combination of infill drilling and EOR in the same project can be very effective. Restine (Restine, 1987) has described an infill drilling project carried out after completion of a tertiary steamflood, and reported incremental oil recoveries of 4 to 7 percent OOIP after infilling from 1.25 to 0.625 acres per well. Alternatively, infill drilling prior to tertiary miscible or chemical process has the benefits of better pattern control, shorter project life (better ROR), and improved areal/vertical sweep. The incremental recovery generated by the infill wells may be more than sufficient to pay out these wells prior to the tertiary project's initiation.

In the foregoing, the word potential has been stressed with regard to additional recovery via infill drilling. This is because the number and quality of infill locations has never been determined on a national basis. The premise here is that a tool is needed to facilitate screening of the many available oil fields in order to quantify the national potential for added recovery and to identify candidates for field evaluations.

Accordingly, the current project was undertaken. Its objectives may be described as follows:

1. To develop the technology of a three-dimensional (stratified, five-spot), two-phase (oil and water) infill drilling predictive model (IDPM), in the form of computer software based upon the mathematics and engineering concepts to be discussed below.

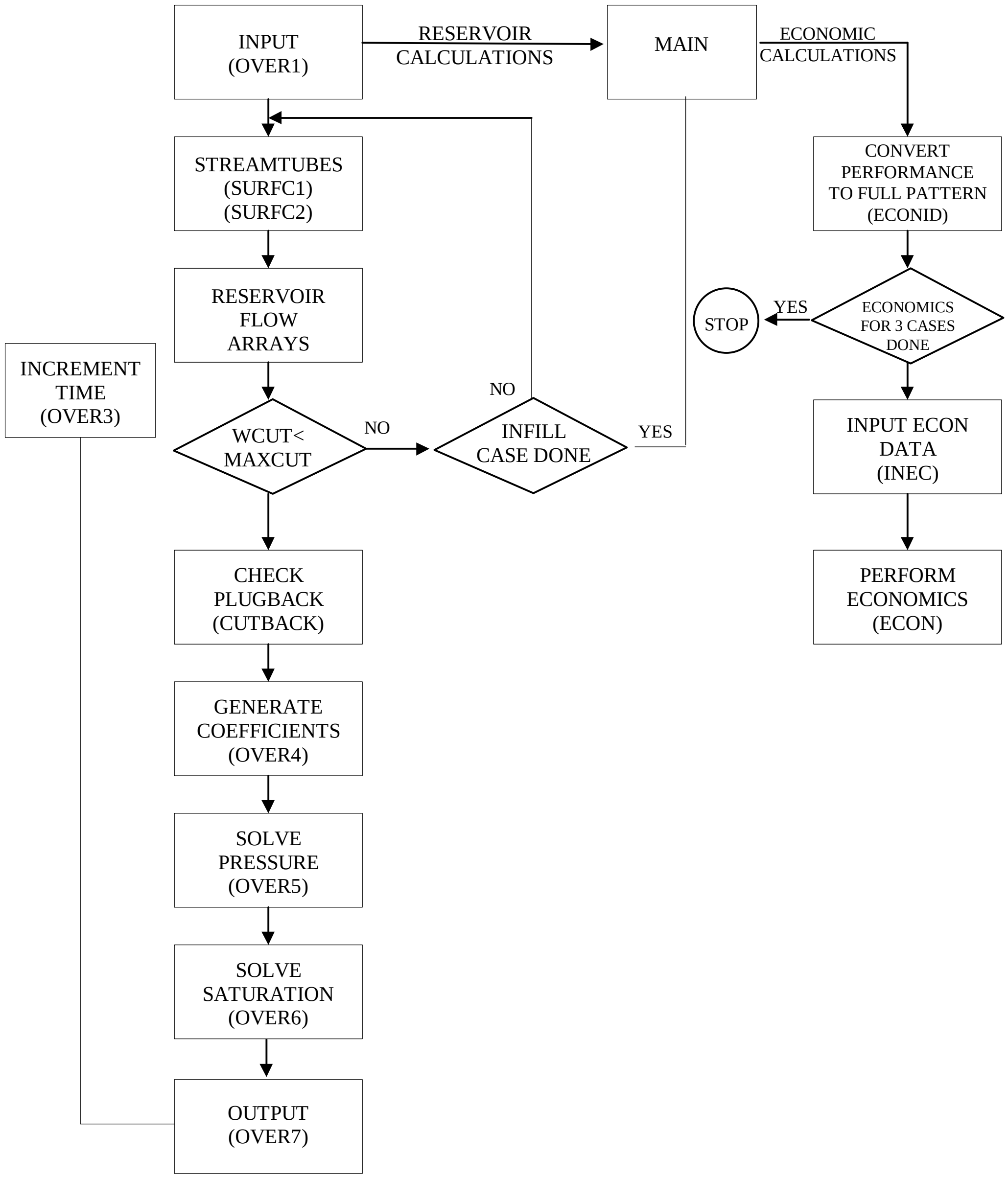
2. To supply the IDPM computer software and associated documentation.

The IDPM documentation includes instructions for model use, a programming guide, model sensitivity runs, and other information as described in the Statement of Work of the original proposal. The computer software consists of IDPM source code suitable for a mainframe computer or for an IBM-compatible personal computer. A logic diagram of the software is shown on Figure 1.1.

TABLE 1-1 -- SUMMARY OF INFILL-DRILLING INCREMENTAL RECOVERIES

Project	No. of Wells	Proj.Vol. (10^6 bbl)	Vol. per Well(10^3 bbl)	Infill Spacing (acres)	Volume (bbl/acre)
Means San Andres					
20-acre infills	141	15.4	109	20	5,450
10-acre infills	16	1.2	75	10	7,500
Fullerton Clearfork	254	24.6	97	20	4,850
RobertsonClearfork	138	10.7	78	18	4,330
IAB (Menielle Penn)	17	1.7	100	40	2,500
Hewitt	15	0.4	27	5	5,400
Loudon	50	0.97	19	10	1,900
YatesSand	247	14.6	59	10	5,900
Grayburg	17	2.44	144	20	7,200
Wasson San Andres (Denver Unit)	293	51.0	174	20	8,700
NorthRiley (Clearfork Unit)	91	13.2	145	20	7,250
Dollarhide Clearfork ("AB" Unit)	44	5.52	125	20	6,250
Total (or well average)	1,323	141.7	107.1	17.5	6,120

Figure 1.1 - PROGRAM LOGIC



1.2 DISCUSSION

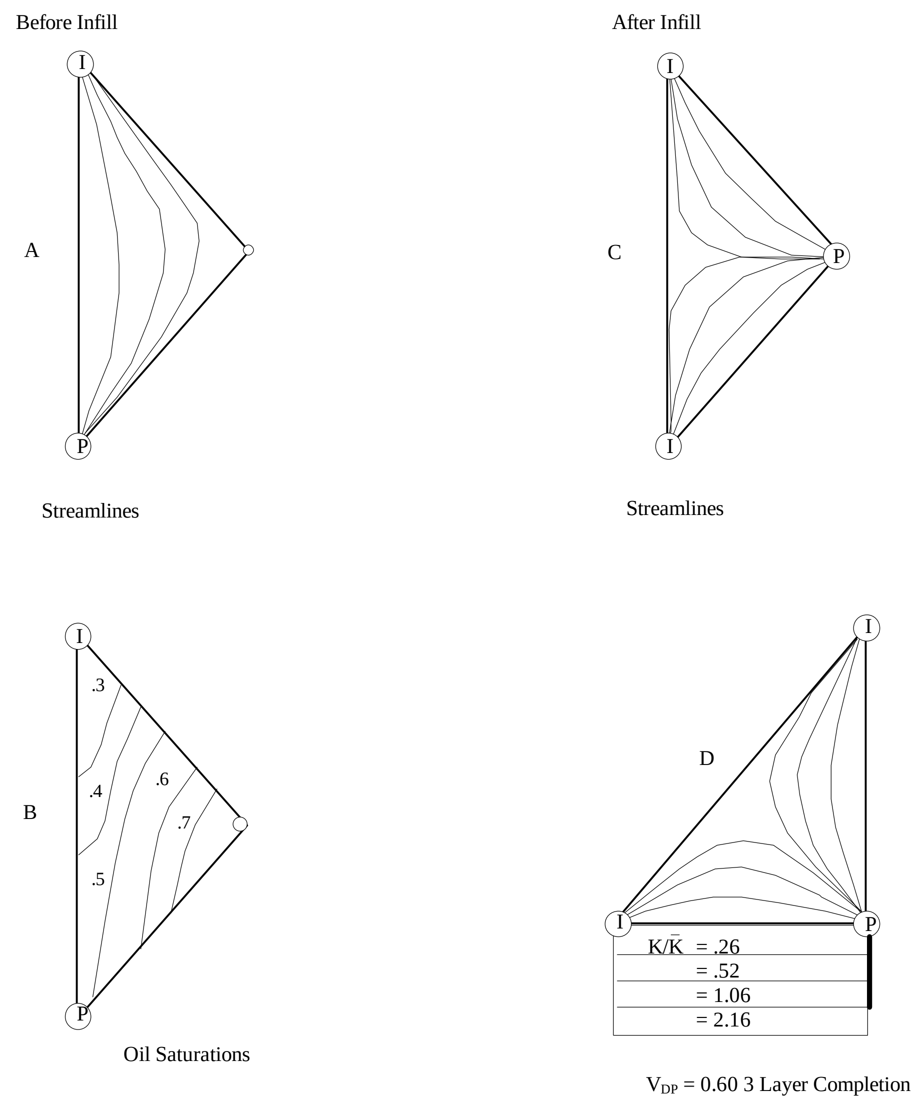
Recovery Mechanisms of Infill Drilling

Driscoll (Driscoll, 1974) ranked the factors responsible for increased oil recovery when secondary patterns are infill drilled in the following order of importance: improved reservoir continuity, improved areal sweep, improved vertical sweep, recovery of wedge edge oil, and improved economic limit.

Improved reservoir continuity is the dominant effect of infill drilling in West Texas carbonates. These reservoirs display significant geologic variation and compartmentalization, and a given well spacing leaves unswept the compartments that are not directly contacted by existing wells. Gould and Sarem (Gould, 1989) have shown that the data of Barbe and Schnoebelen (Barbe, 1986), Barber et al (Barber, 1983), Driscoll (Driscoll, 1974), and Ghauri et al (Ghauri, 1980), all confirm this effect. Improved continuity is primarily responsible for the higher than average incremental recoveries per infill well reported by these authors and by Laughlin et al (Laughlin, 1987).

Improved areal sweep is accomplished by reversing the original streamlines and sweeping across previously unswept areas (sweet spots) as shown schematically in Figure 1.2 for a five-spot pattern. Figure 1.2-A shows the streamlines prior to infill drilling, and 1.2-B shows the corresponding oil saturations. In Figure 1.2-C, the original producer is converted to an injector after the completion of a new producer at the infill location. The new streamlines sweep across the area of highest oil saturation.

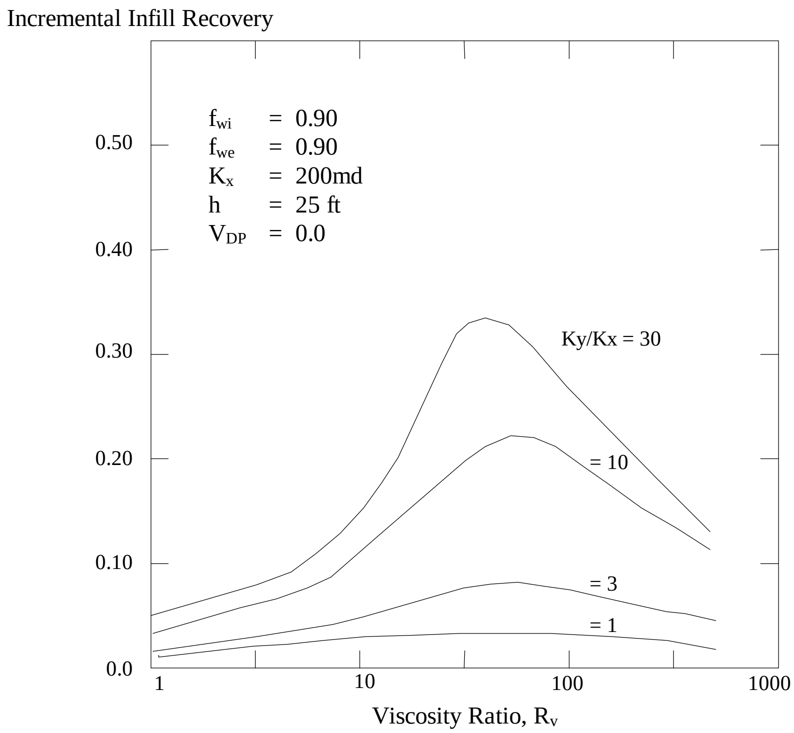
Figure 1.2 -- SCHEMATIC OF INFILL CASES



The amount of incremental recovery due to improved areal sweep depends on the following factors: the degrees of areal heterogeneity or anisotropy, the water cut at the economic limit, the water cut at which infilling occurs, and the mobility ratio of the flood.

For example, Figure 1.3 shows the effect of both directional permeability and viscosity ratio on infill recovery, as determined in the simulation study of Gould and Munoz (Gould, 1982). The higher the ratio of x-direction to y-direction permeability, the greater the infill recovery. This effect is mitigated at high viscosity (mobility) ratios, as the bypassing of oil by fingering takes over.

Figure 1.3. -- EFFECT OF AREAL HETEROGENEITY ON INCREMENTAL RECOVERY



Improved vertical sweep is usually expressed as a function of the Dykstra-Parsons coefficient of permeability variation (Vdp) in multilayer systems. Some idea of cross flow between layers is often an additional consideration. During an infill drilling project, new wells are completed and existing producers are converted to injectors. An opportunity exists at this point to mechanically isolate previously swept zones to maximize vertical sweep. The efficiency of these recompletions depends upon the degree of cross flow between the new (active) zones and the isolated (thief) zones.

Recovery of wedge edge oil may occur as pattern size is decreased, because more oil can be swept near the oil-water contact or stratigraphic features. This is strictly a geometry effect, but can result in flooding of virtually unswept zones.

Improved economic limit of a project which has been infilled results from changes in operating procedures. One of the significant economic benefits of infill drilling is the acceleration of oil recovery. In addition to increasing the number of producers, the field injection rate is increased by more than the well ratio might indicate since the pressure drop between injector and producer occurs over a shorter distance. The operating costs are also reduced, since the water cut is significantly decreased. The actual amount of improvement in economic limit is very company and project dependent, but could easily be in the range of one to two percent OOIP.

These recovery mechanisms form the technical basis for the oil recovery algorithm, and to a lesser degree, the economic algorithm in the IDPM.

The IDPM is switch-selectable for either non-infill or infill cases and an option in the model allows the calculation of the incremental oil recovery and economics of infill relative to non-infill waterflooding. The architecture of the IDPM is similar to that of the other predictive models in the series: in-situ combustion, steam drive (Aydelotte, 1983), chemical flooding (Paul, 1982) and CO_2 miscible flooding (Paul, 1984). In the IDPM, an oil rate versus time function for a single pattern is computed and then is passed to the economic calculations. Data for reservoir and process development, operating costs, and a pattern schedule (if multiple patterns are desired) allow the computation of discounted cash flow and other measures of profitability.

The IDPM is a three-dimensional (stratified, five-spot), two-phase (water and oil) model which computes water-oil displacement and oil recovery using finite difference solutions within streamtubes. The program calculates the streamtube geometries and uses a two-dimensional reservoir simulation to track fluid movement in each streamtube-slice.

The IDPM computes the predicted oil recovery and the associated economics scaled to the entire field, for waterfloods including infill drilling at a user specified water cut. Recovery calculations are computed for the element of symmetry of a layered five-spot pattern.

1.3 ASSUMPTIONS AND FEATURES

The major assumptions in the IDPM include:

1. Compressible fluids and rock.
2. Streamtubes do not change shape with water cut.
3. Streamtubes are independent of mobility ratio.
4. Cross flow between layers within each streamtube.
5. Each layer is homogeneous (perm, porosity, thickness).
6. Layers are anisotropic.

IDPM features include:

1. Recovery as a function of pore volumes injected.
2. Displacement sweep calculated within streamtubes by cross section simulation in cross flow cases. (One-dimensional simulation without crossflow.)
3. Areal sweeps accounted for by streamtube shapes.
4. Streamtube shapes are a function of ky/kx ratio.
5. Vertical sweep by cross flow calculations.
6. Effect of connectivity (reservoir continuity) in reservoir modeled by changes in relative permeability endpoints with spacing.
7. Injectivity effects of infilling can be modeled by switching to constant pressure injection at infill after rate specification for non-fill. Alternatively, the user can specify the injection rate for the infill case.
8. Economics calculated on discounted and undiscounted cash flows for non-infill, infill, and incremental cases.
9. Default reservoir and economic parameters included in the program for most input data.

1.4 STREAMTUBE CALCULATIONS

The generation of streamtubes is a critical aspect of the IDPM software. Recall from the Program Logic diagram given earlier that streamtubes are generated as the starting point both for non-infill and infill waterflood simulation. To promote clarity, the discussion will be given in two parts: (1) an overview of the theory and mathematics that form the basis for the IDPM software, and (2) a discussion of the practical aspects of its implementation and the information supplied to the user.

Technical Overview

The geometries of the streamtubes needed for the watedlooding simulation are obtained from a two-dimensional steady-state areal model of the symmetry element taken from the overall well pattern. This areal model is treated by the Finite Element Method wherein the following assumptions prevail:

1. Unit mobility ratio displacement at steady-state conditions, or, pressures alone may be computed for pseudo-steady state flow.

2. Flow is two-dimensional (x,y) and is not affected by capillarity, gravity, miscibility, phase changes, or relative permeability effects. Flow is governed by Darcy's law and the continuity equation.

3. Flow properties (transmissivity and generation terms) may vary from element to element, but not within any element. Within any element, flow is assumed to be uniform (unidirectional). Anisotropic heterogeneity is allowed, i.e. $ky \neq kx$

4. The finite elements themselves are triangular, and pressure is assumed to be given by a linear basis function within any element.

Formulation of this finite element model is tied to the fundamentals of reservoir fluid flow theory which will be briefly reviewed. That will be followed by a discussion of the derivation of streamtubes from the solution of the finite element problem.

The partial differential equation governing fluid flow through a porous medium is known as the diffusivity equation. In its commonly used form, it is expressed as (Matthews and Russell, 1967):

$$\nabla\left(\frac{k}{\mu} VP\right) = \phi c \frac{\partial P}{Vt}$$

where

k is the permeability of the medium
μ is the fluid viscosity
P is the pressure
ϕ is the porosity
c is the compressibility
t is time

When the pressure profile in the reservoir stabilizes, such that no changes in pressure occur with time, the reservoir is said to be under steady-state flow conditions. This condition will eventually occur in all closed reservoirs where injection and production are balanced. The State that is reached in a closed reservoir when injection and withdrawal are not balanced is known as pseudo-steady state flow; in this instance, a point in time is reached after which the pressure declines (or increases) uniformly throughout the reservoir.

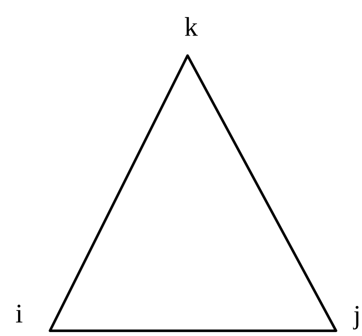
For planar flow, with constant (but not necessarily homogeneous) permeability, porosity, viscosity, compressibility, and thickness 'h', the diffusivity equation for steady-state or pseudo-steady state flow conditions may be written as

$$\nabla \bullet \left(\frac{kh}{\mu} \overline{\nabla} P \right) = f$$

where f denotes a source term. The source term is 0 for steady-state flow and equal to $\phi \, ch \frac{\partial P}{\partial T}$ for pseudo-steady state flow. This equation is a Laplace equation for f=0 or a Poisson equation for $f \neq 0$, and may be solved by the finite element method.

The finite element method is a numerical procedure for dealing with boundary value problems (Zienkiewicz, 1965). It involves minimizing an appropriate integral functional and is an extension of the classical Rayleigh-Ritz methods. The method involves dividing the area over which a solution is desired into a number of elements connected by nodes. A variety of different shapes for the elements can be used; for example, triangles, rectangles, quadrilaterals, etc. Triangles provide a simple form permitting close approximation to boundary shapes and may be easily subdivided for better definition; for this reason, triangular finite elements are utilized in this study.

Within each element, a basis function describing the pressure distribution as a function of the nodal pressures (at the vertices of the triangle, or other points as needed) is assumed. This basis function could be a polynomial, or a sine or cosine expansion, or other arbitrary functions; for simplicity and ease in programming, and to provide rapid solutions, a linear basis function has been applied. Within a typical triangular element defined by the nodes (vertices) i, j, and k, the pressure P specified by a linear basis function (i.e., linear interpolation) is



$$P(X, Y,) = \frac{1}{2\Delta} \left[(a_i + b_i X + c_i Y) P_i + (a_j + b_j X + c_j Y) P_j + (a_k + b_k X + c_k Y) P_k \right]$$

$$\Delta = \frac{1}{2} \det \begin{vmatrix} 1 X_i Y_i \\ 1 X_j Y_j \\ 1 X_k Y_k \end{vmatrix}$$

and $a_i = X_k Y_j - X_j Y_k, b_i = Y_j - Y_k, C_i = X_j - X_k,$ etc. in cyclic order ijk with ijk arranged in counter clockwise order.

As demonstrated in Zienkiewicz and Cheung, the solution of the Poisson equation

$$\frac{\partial}{\partial x}\left(K\frac{\partial P}{\partial x}\right)+\frac{\partial}{\partial Y}\left(K\frac{\partial P}{\partial Y}\right)=f$$

is determined by minimizing a functional, assuming constant K and f within any given element. The equations which result are nodal equations, for pressure as nodal values. The contributions to each node from each element connected to that node are then added together, and ultimately a set of simultaneous linear equations is obtained:

$$[A]\ [P] = [Q]$$

in which

A is an N x N matrix (where N is the number of nodes),
P is a 1 x N matrix to be determined, and
Q is a (known) 1 x N matrix relating to the rate at each node.

The coefficient matrix A is determined from a subsidiary matrix S^e for each element. The S^e matrix depends only on the geometry and flow constant K of the element e. The general term of the 3x3 S matrix for the finite triangular element ijk is

$$S_{ij}^{e}=\frac{K^{e}}{4\Delta^{e}}\left(X_{jk}Y_{ki}+Y_{jk}Y_{ki}\right)$$

when

K^e is the flow constant (kh/μ for the element,
Δ is the area of the element, and
$X_{jk} = X_j - X_k$, etc.

The S matrix is symmetric and positive definite. For non-obtuse triangular elements, the following relation holds

$$S_{ii}=-S_{ij}>0\left(S_{ij}\leq 0,S_{ij}\leq 0\right)$$

For non-obtuse triangular elements, the matrix S is thus loosely diagonally dominant $(S_{ij}\geq\left|S_{ij}\right|+\left|S_{ik}\right|$ and the coefficient matrix A will also be of this form.

The general term of the coefficient matrix A is determined by summing the contributions of the S matrices over the elements any two nodes have in common; thus,

$$A_{ij}=\sum S_{ij}^{e}$$

where the summation is over all elements in common between nodes i and j and where the superscript e denotes the element dependence. For i=j, the number of elements to be summed over will be the number of elements connected to the node i; for $i\neq j$, the number of elements to be summed over will be 0, 1, or 2, depending on how many elements are in common between the two nodes. Because a single node will not commonly be connected to more than a few other nodes, the matrix A will generally be sparse.

The Q matrix (vector) of rates at a node is composed of two parts - a source term and a generation term. If the source at a node i is q_i and the node defines elements with generation f^e (being the right side of Poisson's equation $\nabla \bullet (K\nabla P) = f$ the general term of the Q matrix is

$$Q_i = qi + \sum \tfrac{1}{3} f^e \Delta^e$$

where the summation is over all elements containing node i.

The matrices A and Q are thus seen to be known and the solution of Poisson's equation has been reduced to finding the solution of [A] [P] = [Q]. There are numerous methods available to solve sets of linear equations of this type. Among the properties of the coefficient matrix A are that it is symmetric ($A_{ij} = A_{ji}$), positive definite (implies a number of nice properties, such as a positive determinant, etc.), loosely diagonally dominant $\left(A_{ii} \geq \sum_{j \neq i} |A_{ij}| > 0 \right)$ and it is sparse. Consider a finite element network with, for example 500 nodes, with an average node connected to 6 elements; the coefficient matrix A would have 500 x 500=250,000 entries, of which only 500 x 6 = 3000 (about 1.2%) are non-zero.

A successive over-relaxation (SOR) scheme has been used to solve the system of linear equations. This method involves utilizing existing values of P_1, P_2, . . . , P_{i-1}, P_{i+1}, . . . , P_n to compute the value of P_i, the pressure at node i from its corresponding equation. The pressure computed for the node is then over-corrected ("over-relaxed") to try to account to some extent for future corrections in other pressures. For convergence, the change in pressure at the node during the iteration should be between one and two times the computed change in pressure that yields a straight equality; that is, the over-relaxation parameter (called ω "omega") must be between 1 and 2. Iteration is continued to some maximum number of iterations allowed, or until the change in any nodal pressure becomes less than some prescribed tolerance. Details of the method may be found in most matrix algebra texts.

Successive over-relaxation has two basic difficulties in application: first, a good initial estimate for pressure will greatly reduce computational time; second, for best results, an optimum overrelaxation parameter should be used. Neither of these drawbacks is relevant to the problem at hand. The initial estimate for pressure may be obtained using a coarse grid of elements, with interpolation to obtain an estimate for finer grids. By using this method for the types of problems the program is designed for, convergence is rapid for overrelaxation parameters in the range of 1 to 2.

Once pressure has been determined at the nodal points, it can be interpolated at any point desired. As well, the nodal pressures determine the direction of flow within an element, and its magnitude.

In order to obtain sufficient resolution of the detail for flux patterns within the areal model, one can start with a very coarse finite element mesh and, after solving the problem for that mesh, refine it and re-solve it in as many stages as required to achieve the desired level of solution detail.

The refinement of the grid is accomplished by interpolating a new node between every two connected nodes. Then, every element is divided into four new elements by connecting the interpolated nodes; the four elements replacing an original element are identical in shape to the original element, and each contains one quarter of the area. The number of elements in the fined-up grid is exactly equal to 4 times the number of elements in the original grid, while the number of nodes is multiplied by two or more.

The "final" solution to the finite element problem may be analyzed in various ways. Isobars are readily plotted from the pressure solution alone. Streamlines, which in a homogeneous medium lie orthogonal to the isobars, require a bit more computation. They would be tracings of flux lines from source to sink, based on the flux vector function for which an x-component and a y-component may be computed at any coordinate point. One definition of a streamtube, then, would be an elongated area enclosing a bundle of streamlines, all of which start and end at the same source/sink pair, through which a known volumetric flow of fluid occurs. In simple, two-well patterns, these could be delineated by a contouring of the stream function which may be computed as the line integral of the flux vector along any given isobar. One chooses the width or density of streamtubes to fulfill his requirement for detail in analyzing flow phenomena within the finite element model.

Practical Considerations

Generation of streamtubes in the "real world" of IDPM requires a few additional considerations, superimposed on the technical picture given in the preceding section.

First, we have the matter of well rates to be imposed on the finite element model. Their magnitudes do not matter because the geometry of the streamlines varies only with their relative strengths. When there is one injector and one producer or when the permeability is isotropic, the problem is trivial. However, under anisotropic conditions and with multiple wells of a kind, the fact that we are dealing with symmetry elements requires an external knowledge of their relative magnitudes. Thus, for each of the various anisotropic cases, small black-oil simulation models of the symmetry elements were devised to obtain rates for steady-state flow for a wide range of y-direction to x-direction permeability ratios. Simulator results were treated as raw data to obtain correlations of relative well rate with permeability ratio. These correlations, usually in the form of small tables with an interpolating function, are imbedded into the IDPM source code.

In IDPM, a fine Cartesian grid is used as the medium on which to define the streamtubes. This makes it advantageous to impose a mild restriction on the shape of the triangles in the finite element mesh. By requiring them to be isosceles right triangles with their legs parallel to the coordinate axes, the nodes always coincide with cell comers or cell centers in a Cartesian grid of an appropriate increment. This improves the speed and precision of the software in re-mapping the finite element solution in preparing to generate streamtubes. The finite element solution is represented on the Cartesian grid in terms of the x-component and y-component of flux associated with each grid cell. The FORTRAN arrays QX and QY hold this information which is useful in two different ways: (1) summing (numerically integrating) the total flux crossing an arbitrary line, such as a circle around a source, and (2) tracing a streamline from any given point toward either its source or its sink.

The total flux from a source (or toward a sink) is allocated over some appropriately chosen number of streamtubes. Around any source or sink a circle may be drawn, and points on this circle where streamtube boundaries cross can be found using the QX and QY data. From these points, QX and QY data also support the computations which trace out the bounding streamlines. In principle, then, this is all that is needed to define the geometry of the streamtubes.

If there are multiple sinks and/or multiple sources, one can visualize adjacent streamtubes starting, say, at a source but ending at different sinks. There are two implied difficulties here: (1) proper allocation of the total rate to each streamtube such that no streamtube would tend to split and end at two different sinks, and (2) tracing the bounding streamline between two adjacent streamtubes that must end at different sinks. The former problem is handled by a simple search for the circle crossing point of the unstable bounding streamline to obtain the correct allocation of streamtube rates. The problem of the bounding streamline is readily solved to a good approximation by tracing streamlines that are slightly to either side of the streamtube boundary and then splitting the space between them equally. The latter technique, in fact, is used universally because there are other cases where adjacent streamtubes cannot share a common bounding streamline throughout their length.

Once the geometries of the streamtubes are known (and portions of each source and sink rate allocated to them), the only remaining step is to form the finite difference grid within each of them. The fine Cartesian grid underlies their geometric definition in that the tracing of streamlines and assigning of space between them is done in terms of tagging fine grid cells. Thus, the formation of finite difference cells is also done in terms of assigning fine grid cells to mega-cells within each of the streamtubes. This is accomplished, streamtube by streamtube, by (1) computing for each fine grid cell its relative distance from the source and sink, (2) sorting them on their relative distances and then (3) clumping them into mega-cells of equal (as close as possible) volume The number of these finite difference cells per streamtube is chosen by the user to give the desired level of detail in waterflood simulation results. Forming the mega-cells to have roughly equal volume minimizes the restriction which must be imposed on timestep size in order to maintain stability during waterflood simulation.

In order to allow the user to understand the reservoir mechanics of infill drilling, IDPM supplies a number of items of printed output. This starts with relative permeability tables that apply to the well spacing involved. (These will be discussed in detail in the section to follow.) Next, there is a depiction of the symmetry element to be modeled, showing its positioning in the original overall (5-spot) well pattern. After the geometric layout of the streamtubes within the symmetry element has been determined, a depiction of this geometry is presented. The printout shows exactly which cells in the fine Cartesian grid are assigned to each streamtube. After the finite difference grid within each streamtube has been formed, another printout gives a graphic depiction showing the clumping of fine grid cells into mega-cells. There is also a detailed tabular printout which gives the dimensional and positional properties of these mega-cells for each streamtube. Both of the latter two printouts can easily be omitted if they do not interest the user.

The following figures represent actual IDPM printouts that illustrate some of the points made in the discussions above. First, there are two depictions, for isotropic permeability, of a symmetry element within the overall field showing injector and producer locations for both non-infill and infill well patterns (Figure 1.4). Next, those same two symmetry elements are shown with streamtubes depicted by means of single printer characters giving the streamtube number assigned to each of the fine grid cells (Figure 1.5). Figures 1.6 - 1.9 show the same graphics but for particular infill patterns.

Figure 1.4 -- IDPM OUTPUT EXAMPLE
Symmetry Element, Ky/Kx = 1
5-spot to 5 spot infill

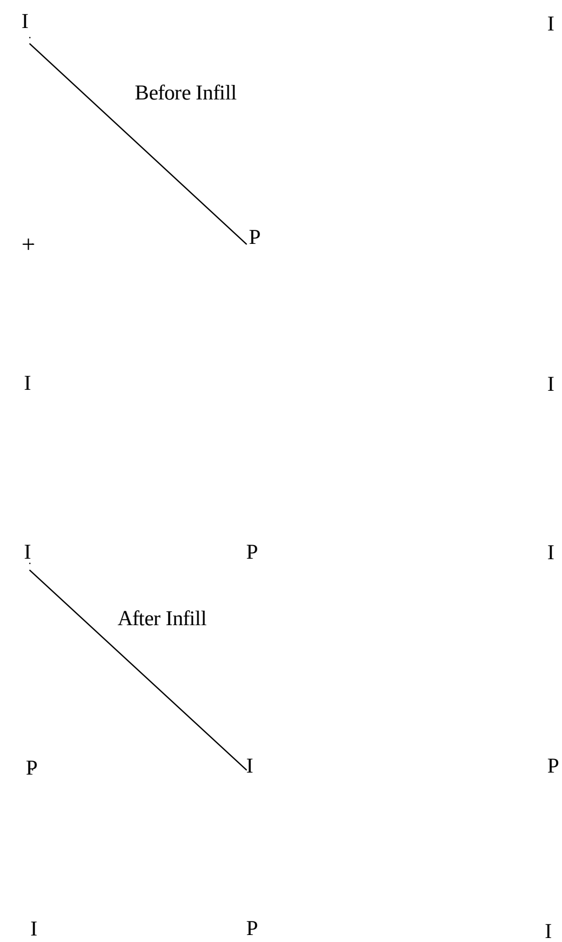


Figure 1.5 -- IDPM OUTPUT EXAMPLE
Streamtube Element, Ky/Kx = 1
5-spot to 5 spot infill

STREAM TUBES - BEFORE INFILL

```
1
61
921
A521
A7421
B86321
B965311
B9764321
BA8654211
BA87643211
CA976543211
CA9876543211
CA98765433211
CBA87765433211
CBA987654432211
CBA9876654432211
CBA98776654332211
CBA998766544332211
CBAA987765544332211
BBAA9887665544332211
BBAA98877655443322211
BBBA998776655443322111
BBBA9988766654443322111
BBBA99887766554433322111
BBBAA99876666554433322111
CCBAA998877665544433322111
CCBAA9988776665544433222111
CCBAA99888776665544333222111
CCBAA999887766665444333222111
CCBAAA998877766555444333222111
CCBAAA9988877666555444333222111
CCBBAA99988777666554444333222111
CCBBAA999888776665554444333222111
CCBBAA9998887776665554443333222111
CCBBAAA9998887776665554443333222111
CCBBAAA99988877766655554443333222111
CCBBAAA999888777766665544443333222111
CCBBAAA9998888777766655544443333222111
CCCBAAAA9998888777666655544443333222111
CCCBBAAA99998887777666655544443333222111
CCCBBAAA999988887777666655544443333222111
CCCBBAAAA9999888877776666555444443332221 11
CCCBBAAAA99998888777776666555544443332221 11
CCCBBBAAAA99998888777776666555544443332221 11
CCCBBBAAAA999998888777776666555544443333221 11
CCCCBBAAAAA999988888777776666555544444333221 11
CCCCBBBAAAAA9999888887777766666555544443332211 1
CCCCBBBAAAAA99999888887777766666555544443332221 1
CCCCBBBBAAAAA999998888887777766666555544443322211
CCCCBBBBAAAAAA999999888887777776666555544443332211
CCCCCBBBBAAAAAA99999988888877777666665555444333221 1
CCCCCBBBBAAAAAAA999999888888777777666665554444332211
CCCCCBBBBBAAAAAAA999999988888877777666665554443322 11
CCCCCCBBBBBAAAAAAAA99999998888887777766666555443322 11
CCCCCCBBBBBBAAAAAAAA9999999988888877777666655544433211
CCCCCCCBBBBBBAAAAAAAAAA99999999888888777776665554433211
CCCCCCCCBBBBBBBAAAAAAAAAA999999999888888777776665544332 11
CCCCCCCCCBBBBBBBBAAAAAAAAAAA99999999988888877776665544322 1
CCCCCCCCCCBBBBBBBBBAAAAAAAAAAAAAA999999999888877766655432 21
CCCCCCCCCCCCBBBBBBBBBBAAAAAAAAAAAAAA99999999888877776654432 1
CCCCCCCCCCCCCCCBBBBBBBBBBBBAAAAAAAAAAAAAA99999998887776654321
CCCCCCCCCCCCCCCCCCCC BBBBBBBBBBBBBBBAAAAAAAAAAA999998887766332 1
CCCCCCCCCCCCCCCCCCCCCCCCCCC BBBBBBBBBBBBBBBBAAAAAAAA999988775421
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC BBBBBBBBBBBBBAAAAA9987631
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC BBBBBBBCCCCCCCCCBBBBAAA951
```

Figure 1.5 -- IDPM OUTPUT EXAMPLE
Streamtube Orientation, Ky/Kx = 1
5-spot to 5-spot infill

STREAM TUBES - AFTER INFILL

```
1
14
135
1216
12356
123456
1234556
11234566
112345566
1123445566
11233445566
112234455566
1122334455666
11223344555666
112233444555666
1122333445556666
11222334445556666
111223344455556666
1112233344455556666
11122333444555566666
111222333444555566666
1112223334445555566666
11122233344445555566666
111122333444455555666666
1112223333444455555666666
11122233334444555555666666
111222333344444555556666666
1112222333444445555566666666
11122223334444455555566666666
111222233344444555555666666666
111222233334444455555666666666
1112222333344444555556666666666
11122223333444445555566666666666
11122223333444445555566666666666 77
1112222333344444555556666666666 7777
111222233344444555555666666666 777777
11122223334444455555566666666 77777777
1112222333444445555556666666 7777777777
1112223333444445555556666666 777777777777
111222333344445555556666666 77777777777777
11122233334444555556666666 7777777777777777
1111223334444555556666666 777777777777777777
111222333444455555666666 77777777777777777777
11122233344455555666666 7777777777777777777777
1112233344445555666666 77777777 88888888 77777777
111223334445555666666 777777 8888888888888 7777777
1112233344455556667777777 888888888888888 777777
112223334445555666777777 8888888888888888888 777777
1122233444555666 77777 88888888888888888888888 77777
1122333445556667777788888888888888888888888888 77777
11223344455566777788888888899999999988888888 77777
11223344555667778888888889999999999999998888888 7777
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11223445566777888888999999999999999999999999988888 7777
1123344556777888899999999999999999999999999999988888 777
112344556677888899999999999 AAAAAAAAAAAAA 99999999998888 777
11234556677888999999 AAAAAAAAAAAAAAAAAAAAAAA 9999988888 77
113345667888999999 AAAAAAAAAAAAAAAAAAAAAAAAAAAAA 999998888 77
12345567888 9999 AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA 99999888 77
1234567889999 AAAAAAAAAAAA BBBBBBBBBBBBBBBBB AAAAAAAAAAAA 999988 77
121567889 99AAAAAAA BBBBBBBBBBBBBBBBBBBBBBBBBBBBBB AAAAAAA 99988 77
12167 8999 AAAA BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB AAAAA 998 77
135789 AAAA BBBBBBBBBBBB CCCCCCCCCCCCCCCCCCCCC BBBBBBBBBBBB AAAA 988 7
1489 AA BBBBBBB CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC BBBBBBB AA 98 7
19BBBB CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC 8889 7
```

Figure 1.6 -- IDPM OUTPUT EXAMPLE
Symmetry Element, Ky/Kx > 1
5-spot to 5 spot infill

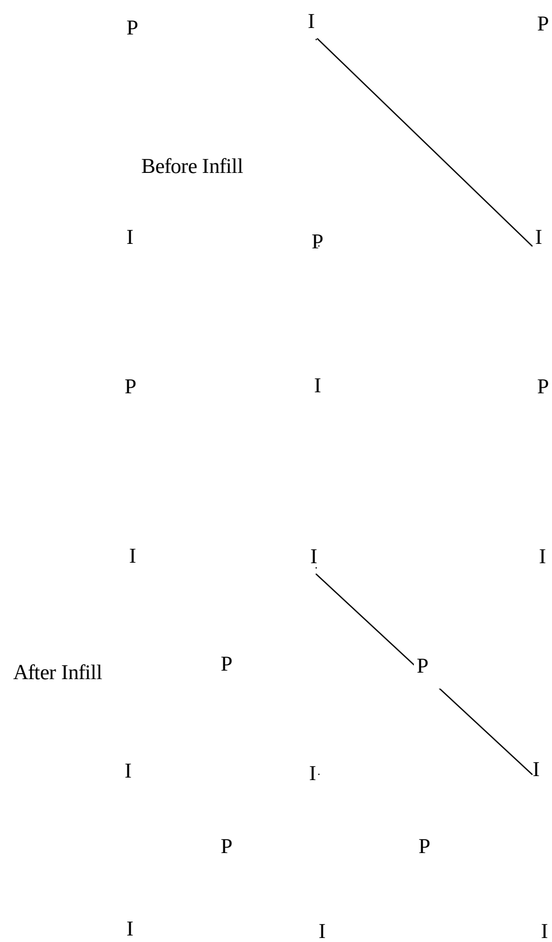

Figure 1.7 -- IDPM OUTPUT EXAMPLE
Streamtube Orientation, Ky/Kx > 1
5-spot to 5-spot infill

STREAM TUBES - BEFORE INFILL

```
3
37
358
3578
34678
346788
3456788
34567888
345677888
3356677888
33456778888
334566778888
3345667788888
33455677788888
334556677888888
3345566777888888
33445667778888888
334456667778888888
3344556677788888888
33445566777788888888
334455666777888888888
3344556667777888888888
33445566677778888888888
333455566777788888888888
3334455667777788888888888
3333555666 7777888888888888
333445566677778888888888888
3334455666777788888888888881
33344556667777888888888888111
333445566677778888888888811111
3334455666677788888888881111111
33344556666777888888888811111111
333445566667778888888881111111111
3334455566777788888888111111111111
33344556667777888888811111111111111
333445566677778888888111111111111111
3334455666777788888881111111111111111
33344556667777888888111111111111111111
333445566677788888811111111111111111111
3333455667777888888111111111111111111111
33345556677778888881111111111111111111111
334455666777788888111111111111111111111111
3344556667778888881111111111111111111111111
33445566677788888111111111111111111111111111
334455667777888881111111111111111111111111111
3344556677788888111111111111111111111111111111
33445566777888811111111111111111111111111111111
334456667788888111111111111111111111111111111111
3344566777888811111111111111111111111111111111111
33455667778881111111111111111111111111111111111111
33455667788881111111111111 222222111111111111111111
3345567778881111111111111 222222222222 1111111111111111
33456677888111111111111 2222222222222222 111111111111111
33456677888111111111 222222222222222222222 1111111111111
3345677888111111111 2222222222222222222222 11111111111111
3356677881111111 222222222222222222222222222 11111111111
34567788811111111 2222222222222222222222222222222 1111111111
3456778811111 2222222222222222222222222222222222 111111111
34567881111111 22222222222222222222222222222222222222 11111111
346788111111 222222222222222222222222222222222222222222 111111
34678111 222222222222222222222222222222222222222222222222 11111
357111111 2222222222222222222222222222222222222222222222 11111
35111222222222222222222222222222222222222222222222222222222 111
31122222222222222222222222222222222222222222222222222222222 11
12222222222222222222222222222222222222222222222222222222222 1
```

Figure 1.7 -- IDPM OUTPUT EXAMPLE
Streamtube Orientation, Ky/Kx > 1
5-spot to 5-spot infill

STREAM TUBES - AFTER INFILL

```
3
36
366
3366
33666
336666
3366666
33366666
333666666
3336666666
33336666666
333366666666
3333366666666
33333666666666
333336666666666
3333336666666666
33333336666666666
333333366666666666
3333333366666666666
33333333366666666666
333333333666666666666
3333333333666666666666
33333333333666666666666
333333333333666666666666
33333333333333 66666666666
333333333333333 6666666666
3333333333333333 6666666666
33333333333333333 666666666
333333333333333 3333666666666
3333333333333333333333 66666666
33333333333333333333333 666666
333333333333333333333333 666666
333333333333333333333333333331
33333333333333333333333333331 27
1111111113333333333333333331111377
1111111111111333333333333333111123 877
11111111111111111111111 5111111112 34777
111111111111111111111111111111 222348777
11111111111111111111111111111 22233487777
1111111111111111111111111111 222233487777
111111111111111111111111111 22223344887777
11111111111111111111111111 2222233448877777
1111111111111111111111 222222233344888777777
11111111111111111 2222222222222222 488887777777
1111111111 22222222222222222223333 4888887777777
11111111 2222222222222222222223333 444888877777777
1111111 22222222222222222222233333 4448888877777777
1111111 222222222222222222233333 44488888777777777
111111 22222222222222222222333333 4444888888777777777
11111 22222222222222222333333333 4448888888 7777777777
1111 2222222222222223333333333333 44488888888 7777777777
1111 22222222333333333333333333333 44448888888 77777777777
111 222222223333333333333333333333 444444 8888888 77777777777
111 22222333333333333333333333 4444444 88888888 77777777777
111 222233333333333333333333 44444444 888888888 77777777777
111 22233333333333333333333 444444444 8888888888 7777777777
11 22233333333333333333333 44444444444 8888888888888 77777777
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11 22333333333 44444444444444444444444 888888888888888 77777777
11 2333333 444444444444444444444444444 888888888888888888 777777
11 23333 4444444444444444444444444444444 88888888888888888888 77777
1 2333 4444444444444444444444444444444444 888888888888888888888 77777
1 2333 4444444444444444444444444444444444 888888888888888888888888 777
1 3 44444444444444444444444444444444444444 8888888888888888888888888888 77
11 4444444444444444444444444444444444444 88888888888888888888888888888 7
```

Figure 1.8 -- IDPM OUTPUT EXAMPLE
Symmetry Element, Ky/Kx > 1
5-spot to 9 spot infill

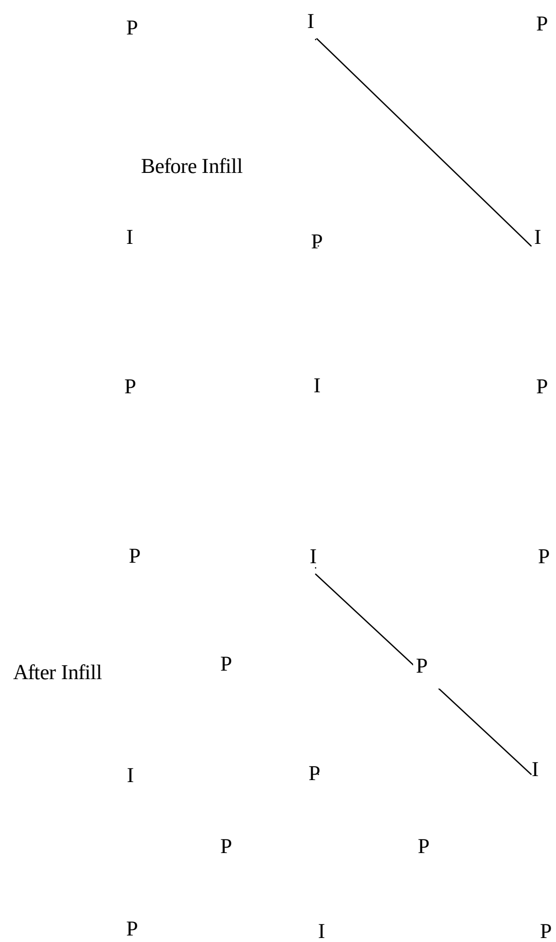

Figure 1.9 -- IDPM OUTPUT EXAMPLE
Streamtube Orientation, Ky/Kx > 1
5-spot to 9 spot infill

STREAM TUBES - BEFORE INFILL

```
3
37
358
3578
34678
346788
3456788
34567888
345677888
3356677888
33456778888
334566778888
3345667788888
33455677788888
334566677888888
3345566777888888
33445667778888888
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334455666777888888888
3344556667777888888888
33445566677778888888888
333455566777788888888888
3334455667777788888888888
3333555666 7777888888888888
333445666677778888888888888
333445566677778888888888888 1
33344556667777888888888888 111
3334455666777788888888888 11111
333445566667778888888888 1111111
33344556666677788888888811111111
3334455666677788888888811111111111
33344555667777888888881111111111111
333445566677778888888111111111111111
3334455666777788888881111111111111111
33344556667777888888811111111111111111
33344555557777888888111111111111111111
333445555577788888811111111111111111111
3333455667777888888111111111111111111111
33345556677778888881111111111111111111111
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3344556677788881111111111111111111111111111111111
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334456667778888111111111111111111111111111111111111
3345566777888111111111111111111111111111111111111111
33455667788881111111111111 2222221111111111111111111
334556777888111111111111 222222222222 1111111111111111
3345567788811111111111 2222222222222222 111111111111111
33456677888111111111222222222222222222222 1111111111111
334567788811111111122222222222222222222222 1111111111111
3356677881111111122222222222222222222222222222 11111111111
34567788811111112222222222222222222222222222222 1111111111
3456778811111122222222222222222222222222222222222 111111111
345678811111122222222222222222222222222222222222222 11111111
346788111112222222222222222222222222222222222222222222 111111
3467811112222222222222222222222222222222222222222222222 11111
3571111122222222222222222222222222222222222222222222222222 11111
351112222222222222222222222222222222222222222222222222222222 111
311222222222222222222222222222222222222222222222222222222222222 11
1222222222222222222222222222222222222222222222222222222222222222 1
```
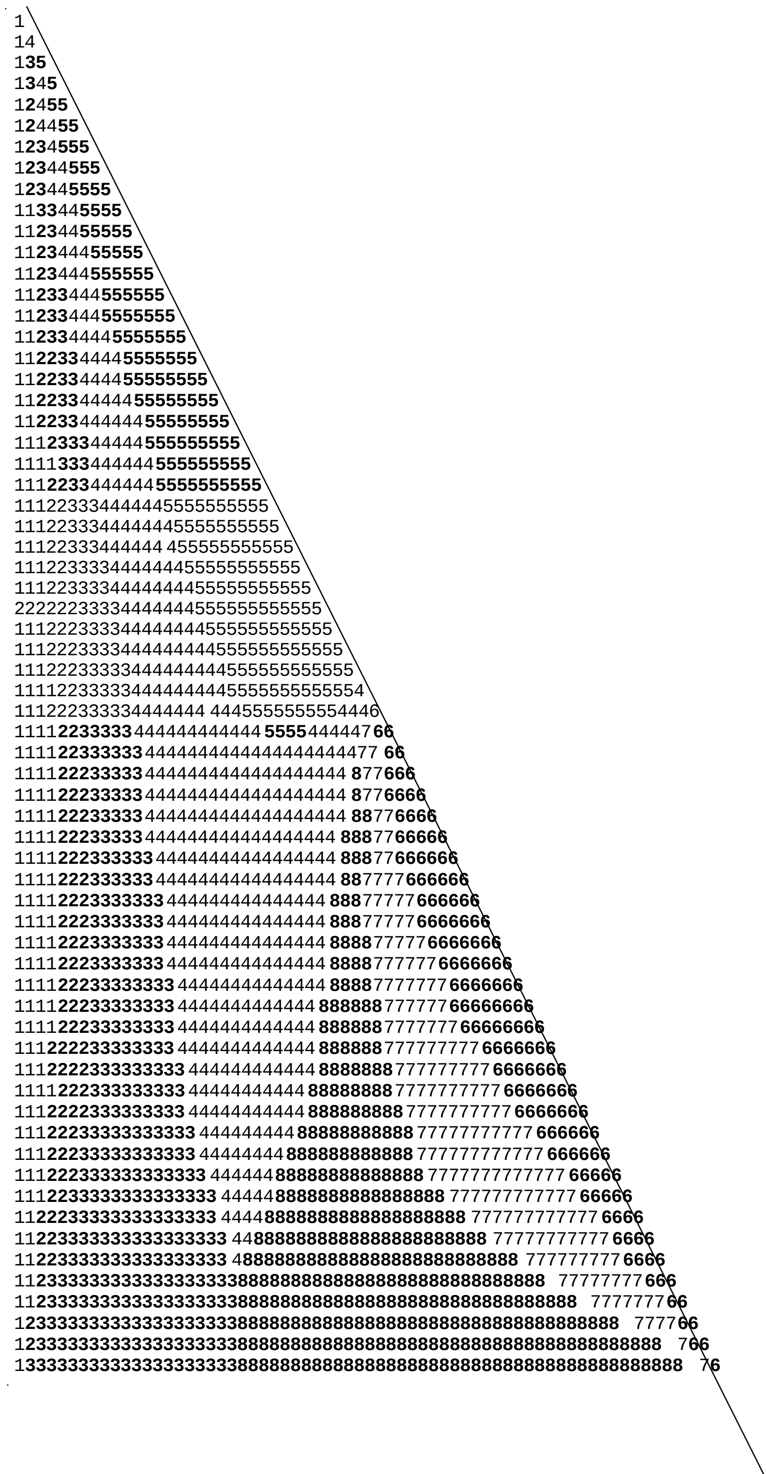

Figure 1.9 -- IDPM OUTPUT EXAMPLE
Streamtube Orientation, Ky/Kx > 1
5-spot to 9 spot infill

STREAM TUBES - AFTER INFILL



Finally, there is the matter of initial saturation conditions for the streamtube finite difference grids. To start the non-infill case, of course, oil saturation is uniform. At the start of the infill case, however, the oil saturation in each cell must reflect the distribution that existed at the point in time where infill would have occurred in the non-infill case. Since the geometries of the streamtubes in those two cases are never the same, the mega-cells will always overlap in an irregular manner. This is resolved by once more resorting to the fine Cartesian grid, first mapping mega-cell saturations from the non-infill grid (at the time for infill) back onto the fine grid. Then initial saturation for each infill mega-cell is obtained by volumetric averaging over its fine grid cells. (Cell volumes in the fine grid are all the same except for those on the boundary.) The result is no loss of material balance in the transition to the infill case.

1.5 RESERVOIR SIMULATOR CALCULATIONS

The production/injection performance of each well in the modeled element of symmetry is calculated by summing up the performance of each streamtube described in the previous section. The performance within each streamtube -- or stack of streamtubes for vertical communication cases - is based on a finite difference simulation.

The production end of each streamtube is fixed at a constant pressure -- slightly less than the initial reservoir pressure -- and the injection end of each stream is set at a constant water injection based on the user input total pattern injection rate. For non-infill runs the allocation of the input rate to each streamtube is based on the range of stream function values within each streamtube from the calculations described in the previous section. For infill cases, if no injection rate is specified, the pressure at the injection end of each streamtube is set at the average pressure from all the injection cells in the non-infill case. In this manner the increased injectivity due to infilling is automatically calculated by the simulator.

With these boundary conditions the water-oil displacement in each streamtube -- or stack of streamtubes - is calculated by the reservoir simulator as described below.

Fundamental Flow Equations and Their Solution

The fundamental flow equations and their solution constitute the heart of a fluid flow simulator. The derivation of the equations is simple in concept, though fraught with mathematical manipulation. The following is based on the 3-D three-phase treatment given by Breitenbach et al (Breitenbach, 1968).

A fundamental flow equation can be derived for each phase in a streamtube by combining the law of conservation of mass, the law of force, and thermodynamic relationships that describe the pressure-volume-temperature behavior of the fluid. The law of conservation of mass simply states that for each cell of porous media:

(Net flow of mass) + (change of mass in block)

+ (mass produced) = 0.

In other words, it is a mass or material balance that states that no mass can be gained or lost from the system. The law of force used is Darcy's law. The thermodynamic relationships that are used are found experimentally, and consist of the slightly compressible fluid descriptions. If the following assumptions are made:

1. Isothermal, immiscible, Darcy flow,

2. Stock tank fluid densities remain constant within a time increment, and

3. Rock porosity changes with pressure follow the relationship:

$$\phi = \phi_{original}\left[1 + C_r\left(p - p_{original}\right)\right],$$

then the following equations for oil and water can be derived:

Oil:

$$\frac{\partial}{\partial x}\left(\frac{q_{oR}}{\beta_o}\right)\delta x + \frac{\partial}{\partial y}\left(\frac{q_{oR}}{\beta_o}\right)\delta y + \frac{\partial}{\partial z}\left(\frac{q_{oR}}{\beta_o}\right)\delta z$$

+ oil production rate

$$+\left[\frac{S_o V_b C_r \phi_{orig}}{\beta_o} + S_o V_b \phi \frac{\partial}{\partial p_o}\left(\frac{1}{\beta_o}\right)\right]\frac{\partial p_o}{\partial t}$$

$$= \frac{V_b \phi}{\beta_o}\frac{\partial S_o}{\partial t}$$

Water:

$$\frac{\partial}{\partial x}\left(\frac{q_{wR}}{\beta_w}\right)\delta x + \frac{\partial}{\partial y}\left(\frac{q_{wR}}{\beta_w}\right)\delta y + \frac{\partial}{\partial z}\left(\frac{q_{wR}}{\beta_w}\right)\delta z$$

+ water production rate

$$+\left[\frac{S_w V_b C_r \phi_{orig}}{\beta_w} + S_w V_b \phi \frac{\partial}{\partial p_w}\left(\frac{1}{\beta_w}\right)\right]\frac{\partial p_w}{\partial t}$$

$$= \frac{V_b \phi}{\beta_w}\frac{\partial S_w}{\partial t}$$

These equations are solved by approximating the differential equations with finite difference representations, and then solving the algebraic difference equations as an approximation to the differential equation. The finite difference representations are based on the grid cells determined for each streamtube -- or stack of streamtubes -- in the previous section. For our two phase 2-D simulator - two dimensions to include crossflow between the layers - the finite difference representations for the (n+ 1)th time step are:

Oil Saturation Equation:

$$
\begin{aligned}
&\frac{1}{\Delta t}\left[\left(\frac{S_o V_p}{\beta_o}\right)^{n+1} - \left(\frac{S_o V_p}{\beta_o}\right)^{n}\right] \\
&= A_{oe}\left[p_e^{n+1} - P_c^{n+1} + \gamma_{oe}^{n}(Z_e - Z_c)\right] \\
&+ A_{ow}\left[p_w^{n+1} - P_c^{n+1} + \gamma_{ow}^{n}(Z_w - Z_c)\right] \\
&+ A_{ot}\left[p_t^{n+1} - P_c^{n+1} + \gamma_{ot}^{n}(Z_t - Z_c)\right] \\
&+ A_{ob}\left[p_b^{n+1} - P_c^{n+1} + \gamma_{ob}^{n}(Z_b - Z_c)\right]
\end{aligned}
$$

where:

Z_c	=	midpoint elevation of center cell
Z_e	=	midpoint elevation of east cell
Z_W	=	midpoint elevation of west cell
Z_t	=	midpoint elevation of top cell
Z_b	=	midpoint elevation of bottom cell

$$V_p^n = \Delta X\,\Delta Y h \phi_{orig}\left[1 - C_r\left(P_{ref} - P_c^n\right)\right],$$

$$\gamma_{oe}^n = \left[\left(\rho_o\left(P_e^n\right) + \rho_o\left(P_c^n\right)\right)\right] / 288$$

$$A_{oe} = \frac{4.0 T_{ec} k_{ro}^{u}\left(S_o^n\right)}{\left(\beta_o\left(P_e^n\right) + \beta_o\left(P_c^n\right)\right)\left(\mu_o\left(P_e^n\right) + \mu_o\left(P_c^n\right)\right)}$$

$$T_{ec} = \frac{0.01266 \Delta Y_c h_e h_c k_{xc} k_{xe}}{\Delta X_c h_e k_{xe} + \Delta X_e h_c k_{xc}}$$

k_{ro}^{u} evaluated at upstream cell.

Similar, obvious, formulas can be written for A_{ow}, A_{ot} and A_{ob} as well as T_{wc}, T_{tc}, and T_{bc}.

Water Satuation Equation:

$$
\begin{aligned}
&\frac{1}{\Delta t}\left[\left(\frac{S_w V_p}{\beta_w}\right)^{n+1} - \left(\frac{S_w V_p}{\beta_w}\right)^{n}\right] \\
&= A_{we}\left[p_e^{n+1} - P_c^{n+1} + \gamma_{we}^{n}(Z_e - Z_c)\right] \\
&+ A_{ww}\left[p_w^{n+1} - P_c^{n+1} + \gamma_{ww}^{n}(Z_w - Z_c)\right] \\
&+ A_{wt}\left[p_t^{n+1} - P_c^{n+1} + \gamma_{wt}^{n}(Z_t - Z_c)\right] \\
&+ A_{wb}\left[p_b^{n+1} - P_c^{n+1} + \gamma_{wb}^{n}(Z_b - Z_c)\right]
\end{aligned}
$$

where all terms are exactly analogous to those in the oil saturation equation. Note, however, the absence of oil-water capillary pressures which would combine with oil pressure to give water pressures; we are assuming $P_W = P_O$

Source/sink terms may appear. Their units are the same as those for their respective equation, namely, stock tank cubic feet (of fluid) per day.

Note that, after p^{n+1} values are available from solution of the forthcoming set of simultaneous linear pressure equations, all (n+1) level PVT functions can be evaluated. Thus, each saturation equation for each grid cell can be solved for its (n+1) level saturafion value, independent of the values in other grid cells, or explicitly.

The task at hand now is to combine the saturation equations through use of the relation:

$$S_o + S_w = 1.0$$

and to approximate the (n+1) level PVT functions to obtain, finally, a linear equation (for each grid cell) where the only (n+ 1) quantities are oil pressures.

We start by multiplying each saturation equation by its corresponding β^{n+1}. For conciseness, the summation notation $\sum_{i=1}^{4}$ has been employed with the understanding that i=1,2,3,4 corresponds to the positional subscripts, e,w,t,b.

$$\beta_o^{n+1}\sum_{i=1}^{4} A_{oi}\Delta\phi_{oi} = S_o^{n+1}\frac{V_p^{n+1}}{\Delta t} - \frac{S_o^n V_p^n \beta_o^{n+1}}{\beta_o^n \Delta t} - \beta_o^{n+1} q_o$$

$$\beta_w^{n+1}\sum_{i=1}^{4} A_{wi}\Delta\phi_{wi} = S_w^{n+1}\frac{V_p^{n+1}}{\Delta t} - \frac{S_w^n V_p^n \beta_w^{n+1}}{\beta_w^n \Delta t} - \beta_w^{n+1} q_w$$

We will add these two equations and eliminate S_o^{n+1}, S_w^{n+1} by use of $\left(S_o^{n+1} + S_w^{n+1}\right) = 1$ and elim-inate $\left(S_o^{n+1} V_p^{n+1}\right)/\beta_o^{n+1}$ by substituting the entire oil equation and similarly for $\left(S_w^{n+1} V_p^{n+1}\right)/\beta_w^{n+1}$.

After all the algebra is done, we have the following:

$$\beta_o^{n+1}\sum_{i=1}^{4} A_{oi}\Delta\phi_{oi} + \beta_w^{n+1}\sum_{i=1}^{4} A_{wi}\Delta\phi_{wi} = \frac{V_p^{n+1}}{\Delta t} - \frac{V_p^n}{\Delta t}\left(\frac{S_o^n\beta_o^{n+1}}{\beta_o^n} + \frac{S_w^n\beta_w^{n+1}}{\beta_w^n}\right) - \beta_o^{n+1}q_o - \beta_w^{n+1}q_w$$

We now use the following approximations to convert the right-hand side (except for source/sink terms).

$$V_p^{n+1} = V_p^n\left[1 + C_r\left(p^{n+1} - p^n\right)\right]$$

$$\beta_o^{n+1} = \beta_o^n + (d\beta/dp)*\left(p^{n+1} - p^n\right)$$

$$\beta_w^{n+1} = \beta_w^n + (d\beta_w/dp)*\left(p^{n+1} - p^n\right)$$

This obtains the expected terms with the compressibility forms, for $C_o = \frac{-1}{\beta_o^n}\frac{d\beta_o}{dp}$, similar for C_w and finally $C_t = C_r + C_0S_0 + C_wS_w$.

Then the “final" pressure equation can be written. The remaining $\beta_o^{n+1}, \beta_w^{n+1}$, values are simply approximated with nth time level values.

$$\sum_{i=1}^{4}\left(p_i^{n+1} - P_c^{n+1}\right)\left(A_{oi}\beta_o^{n+1} + A_{wi}\beta_w^{n+1}\right) - \frac{V_p^nC_t}{\Delta t}p_c^{n+1} = \frac{-V_p^nC_t}{\Delta t}p_c^n - \sum_{i=1}^{4}\beta_o^{n+1}A_{oi}\left[\gamma_{oi}\left(Z_c - Z_i\right)\right]$$

$$-\sum_{i=1}^{4}\beta_w^{n+1}A_{wi}\left[\gamma_{wi}\left(Z_c - Z_i\right)\right] - \beta_o^{n+1}q_o - \beta_w^{n+1}q_w$$

The pressure equations form a set of simultaneous equations that are solved using an LSOR solution technique. The saturation equations are then solved explicitly one at a time.

Relative Permeability Relationships

The relative permeability in the previous discussion is computed from Corey-type equations based on user input end values:

UO	=	(1.0-SW-SORW) / (1.0-SWC-SORW)
KRO	=	XKROE*UO**XNO
UW	=	(SW-SWC)/(1.0-SWC-SORW)
KRW	=	XKRWE*UW**XNW

XNO and XNW are curve shape parameters, with default values of 2.

Methods of Modeling Continuity

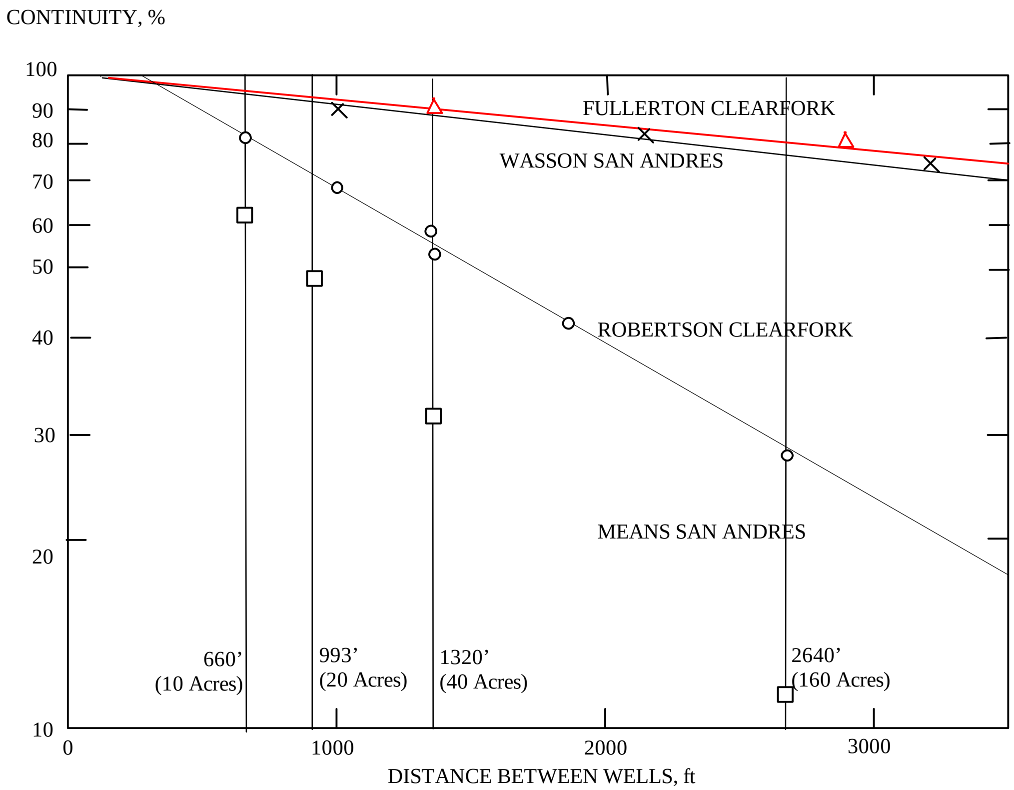
IDPM features two approaches to the calculation of continuity which are user-selectable via entries on cards R2 and R3. The first method is incorporated in the model as originally provided by SSI and calculates continuity by adjusting the relative permeability endpoint to oil, SORW in the above relationships. The second method was devised by ICF Resources Incorporated. This approach models continuity by adding an extra layer of net pay. Each of the two methods is discussed below.

SSI Method

This approach models changes in reservoir continuity -- or connectivity -- by changes in the relative permeability endpoint to oil, SORW in the relative permeability relationships described above. This technique was used to assure that the initial oil-in-place is not a function of spacing, but the "average" final oil-in-place after a waterflood will be a function of spacing.

The input relative permeability endpoints are assumed to be laboratory values which apply at conditions of 100 percent continuity (or connectivity). The modificajions to SORW require a value for the continuity fraction for both non-infill and infill. These are assumed to be dependent on the well spacing associated with those two cases. VCONEC, the user-input value, is used for non-infill. The continuity value for infill is obtained by computation of the decreased well spacing and reference to a semilog plot such as that shown in Figure 1.10. This plot is defined by user input.

Figure 1.10 -- CONTINUITY ASSOCIATED WITH NON-INFILL AND INFILL SPACING



The input endpoint value of SORW is then changed to make the fraction of the laboratory mobil oil phase that is discontinuous at reservoir conditions be represented by oil saturations between the input SORW and the SORW value calculated for the continuity associated with the non-infill and infill spacing:

$$SORW_{used} = SORW + (1+VCONEC) * (l-SWI-SORW)$$

This means of treating reservoir continuity changes assures accurate calculations of ultimate recovery changes due to improved continuity for infill operations. However, the discontinuous nature of the reservoir would mean that an infill well could encounter reservoir rock at initial oil saturation - SOI. In this case the initial oil rate would be much higher in the field than in IDPM, but cumulative performance should be accurate.

Additional Net Pay Method

In this method, improved continuity is modeled as additional net pay. When the infill is initiated, an extra layer is added to the model to reflect this increase in net pay. The effective net pay at a particular value of continuity is defined as:

$$h_e = h_t*C$$

where:

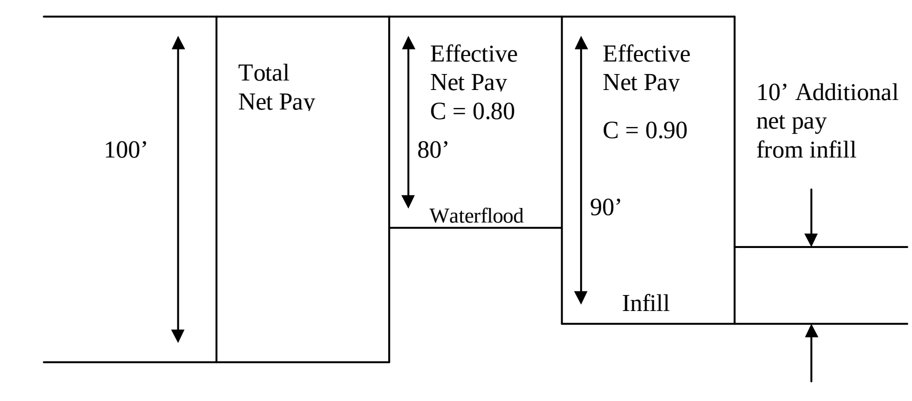
h_e = effective net pay at continuity C
h_t = effective net pay at continuity of 1.0

Values of effective net pay can be calculated using values of continuity at the original and infill spacings. The incremental net pay as a result of infill is the difference between net pay, an average value of permeability, and an initial oil saturation of 1.0 - S_{WC} - 0.07. This method is shown schematically in Figure 1.11.

Figure 1.11 -- Modeling Continuity by Changing Net Thickness

Assume:

Net Pay	=	100' (100% continuity)
Continuity	=	0.80 (At original spacing)
Continuity	=	0.90 (At infill spacing)



At infill, add 10' of net pay, with a permeability of $\bar{k}$ and an oil saturation of (1-Swc)

Comparison of Methods to Model Continuity

A comparison of the residual oil saturation and net pay methods was performed with the IDPM at three mobility ratios (1.0, 2.5, 5.0). The results are presented in Tables 1.1 through 1.3 respectively. Both continuity and VDP were varied for each mobility ratio studied.

TABLE 1.2
COMPARISON OF METHODS TO MODEL CONTINUITY

Cumulative Oil Recovery, Mobility Ratio = 1.0

	VDP = 0.5							
	Continuity = 0.5				Continuity = 0.8			
	Waterflood		Infill		Waterflood		Infill	
	MSTB	% OOIP	MSTB	% OOIP	MSTB	% OOIP	MSTB	% OOIP
Layer Method	227	21.5	97.6	9.3	363	34.3	45.0	4.3
SORW Method	227	21.5	92.7	8.8	362	34.3	40.3	3.8
7% Adjusted Layer Method	227	21.5	81.2	7.7	363	34.3	37.6	3.6

	VDP = 0.8							
	Continuity = 0.5				Continuity = 0.8			
	Waterflood		Infill		Waterflood		Infill	
	MSTB	% OOIP	MSTB	% OOIP	MSTB	% OOIP	MSTB	% OOIP
Layer Method	163	15.4	95.9	9.1	261	24.7	45.8	4.3
SORW Method	163	15.4	69.6	6.6	261	24.7	33.8	3.2
7% Adjusted Layer Method	163	15.4	80.5	7.6	261	24.7	38.3	3.6

7 Streamtubes
10 Layers (+ 1 layer for layer methods)
11 Cells per stream tube
OOIP = 1057 MSTB
Infill @ water cut of 0.85
Terminate run @ water cut of 0.95

TABLE 1.3
COMPARISON OF METHODS TO MODEL CONTINUITY

Cumulative Oil Recovery, Mobility Ratio = 2.5

	VDP = 0.5							
	Continuity = 0.5				Continuity = 0.8			
	Waterflood		Infill		Waterflood		Infill	
	MSTB	% OOIP	MSTB	% OOIP	MSTB	% OOIP	MSTB	% OOIP
Layer Method	208	19.7	90.6	8.6	333	31.5	40.9	3.9
SORW Method	208	19.7	86.7	8.2	332	31.4	39.0	3.7
7% Adjusted Layer Method	208	19.7	75.1	7.1	333	31.5	33.8	3.2

	VDP = 0.8							
	Continuity = 0.5				Continuity = 0.8			
	Waterflood		Infill		Waterflood		Infill	
	MSTB	% OOIP	MSTB	% OOIP	MSTB	% OOIP	MSTB	% OOIP
Layer Method	150	14.2	91.0	8.6	240	22.7	43.8	4.1
SORW Method	151	14.3	64.0	6.1	241	22.8	30.3	2.9
7% Adjusted Layer Method	150	14.2	75.6	7.2	240	22.7	36.8	3.5

7 Streamtubes
10 Layers (+ 1 layer for layer methods)
11 Cells per stream tube
OOIP = 1057 MSTB
Infill @ water cut of 0.85
Terminate run @ water cut of 0.95

TABLE 1.4
COMPARISON OF METHODS TO MODEL CONTINUITY

Cumulative Oil Recovery, Mobility Ratio = 5.0

	VDP = 0.5							
	Continuity = 0.5				Continuity = 0.8			
	Waterflood		Infill		Waterflood		Infill	
	MSTB	% OOIP	MSTB	% OOIP	MSTB	% OOIP	MSTB	% OOIP
Layer Method	189	17.9	83.9	7.9	302	28.6	40.0	3.8
SORW Method	189	17.9	78.5	7.4	302	28.6	35.8	3.4
7% Adjusted Layer Method	189	17.9	68.4	6.5	302	28.6	32.9	3.1

	VDP = 0.8							
	Continuity = 0.5				Continuity = 0.8			
	Waterflood		Infill		Waterflood		Infill	
	MSTB	% OOIP	MSTB	% OOIP	MSTB	% OOIP	MSTB	% OOIP
Layer Method	138	13.1	83.6	7.9	220	20.8	39.4	3.7
SORW Method	137	13.0	59.4	5.6	219	20.7	28.8	2.7
7% Adjusted Layer Method	138	13.1	68.2	6.5	220	20.8	32.3	3.1

7 Streamtubes
10 Layers (+ 1 layer for layer methods)
11 Cells per stream tube
OOIP = 1057 MSTB
Infill @ water cut of 0.85
Terminate run @ water cut of 0.95

The results show that waterflood performance is not affected by the choice of continuity method whereas infill recovery is. The net pay ("layer”) method yields the highest infill recovery because it gives a higher oil rate at infill initiation. Either the "7% adjusted layer" method or the SSI method infill results are lowest depending on mobility ratio. Infill recovery is driven primarily by continuity, and thus the method used to model continuity. As expected, infill recovery was not greatly affected by mobility ratio. This is because in the IDPM (as in all streamtube models), the streamtube shapes and volumes are calculated assuming unit mobility.

Simulation Printout

IDPM offers several different types of printed output to provide the user with information about the waterflooding simulation calculations. These are available for both the non-infill case and the infill case. First, there is a summary of the in-place volumes (for all streamtubes). These volumes, like all other output from simulation, are scaled up to the size of the symmetry element which has 1/8 (if ky/kx = 1) or 1/4 (if kry/kx>>1) of the area of the pre-infill 5-spot well pattern. The printout also includes periodic summaries (coming at about 0.1 pore volume of injected water) of production/injection rates and cumulative volumes. These are followed by tabulations, covering every timestep, of production rates and cumulative oil, watercut, fractional recovery, etc. for both non-infill and infill.

Plot output

The EOR Plotting Package (EORPP) originally developed for use with the PC version of the DOE EOR models has been adapted for use with the IDPM. The IDPM version outputs three groups of four plots each for every economic scenario selected. Since the economic data for a given reservoir includes three scenarios (continued waterflood, infill drilling, and incremental infill drilling), a total of 36 plots are produced. The plots are designed for 11" x 14 7/8 printer paper and measure 80 lines high by 132 characters wide. The first group of plots includes pattern oil production vs. time (years), pattern water production vs. time, project oil production vs. time, and project water production vs. time. The second group contains cumulative project oil production vs. time, cumulative project water production vs. time, pattern water-oil ratio vs. time, and project water-oil ratio vs. time. The third group contains pattern water injection vs. time, project water injection vs. time, cumulative pattern water injection vs. time, and cumulative project water injection vs. time. The plots are invoked by setting the economics control switch on card R2 to a value of 2.

1.6 ECONOMIC CALCULATIONS

The IDPM economic calculations are used to convert predicted performance data from the oil recovery algorithm into a cash flow analysis extending over the life of the project. This analysis combines forecasts of revenue, costs, expenses, and taxes into an annual balance sheet (see Appendix III b). The model also permits an evaluation of the uncertainty of filture earnings as a result of changes in key variables and thus an evaluafion of project risk.

The economic calculations require three types of data:

1. Project definition (pattern development schedule). Once the performance of a single pattern has been determined, a schedule of the number of patterns per year to be initiated is used to superpose the pattern rates into an overall project performance. This procedure implicitly assumes that all patterns in the project perform identically (i.e., second year oil and water rates for every pattern are the same regardless of when the pattern comes on stream). Also superposed are the capital costs of drilling and equipping wells associated with developing each pattern. From this schedule, the total multiple patterns project oil, water and gas rates are calculated as well as the total amount of fluid injected. By combining the well and pattern implementation schedules, a capital investment schedule is obtained. A fraction of this capital investment schedule is obtained. A fraction of this capital requirement may be borrowed and repaid over the life of the project. The fixed and variable operating costs are then calculated based upon the project performance schedule. These latter costs include such items as maintenance costs, water treating and disposal costs, etc.

2. Economic data. These include prices, costs, tax rates, discount rate, escalation (inflation) rates, and capital schedule.

3. Range of uncertainty for key variables.

Estimating Risk

The parameter method (Davidson, 1976) is used to compute uncertainty in present value. This method deals with the parameters of the probability distributions rather than the distributions and, with reasonable assumptions about distribution form, can estimate the probability of achieving various levels of present value.

The parameter method requires that the uncertain parameters (data) must be statistically independent. For this reason, uncertainty in performance of the reservoir is considered as a single parameter (UNCO). Other variables, such as costs, revenues and expenses, should be mutually independent. If dependence between parameters is established, the parameters should be rearranged to minimize dependence. In the IDPM, unit prices, costs, and capital are defmed as the uncertain variables, in addition to the uncertamty in oil production. Escalation, inflation and tax rates are treated as certain and constant values over the life of the project.

The mean and variance of each of the uncertain variables are then estimated. The mean is the weighted average value of all possibilities found in the probability distribution of a parameter, and the variance is the weighted average of all squares of differences from the mean. Three values of a parameter are used to calculate the mean and variance:

1. Low value - a value of the parameter small enough so that only a 10 percent chance exists of a smaller value;

2. The most likely value; and

3. High value - a value large enough that there is only a 10 percent chance of a higher value.

Finally, the means and variances are combined into the quantities of interest, such as revenues, expenses, and costs. Once combined, the assumption of a resulting log-normal distribution is made. The mean and variance of the present value are lcnown and estimations of present value at 10% (upside potential), 50%, and 90% (downside risk) probability are computed.

Profitability Indices

The calculated mean (50 percent) present value is presented in various formats to allow the direct comparison of costs and benefits. The present value of project revenues, costs and expenses are also reported to allow for an analysis of the components of project present value.

The final economic results are presented in terms of four measures of profitability:

1. Discounted Cash Flow (DCF), which represents the present value profit of the project;

2. Discounted Cash flow Rate of Return (DCFROR), which is the discount rate that reduces the DCF to zero;

3. Profit-to-Investment Ratio (P/I), which is the present value per dollar invested; and

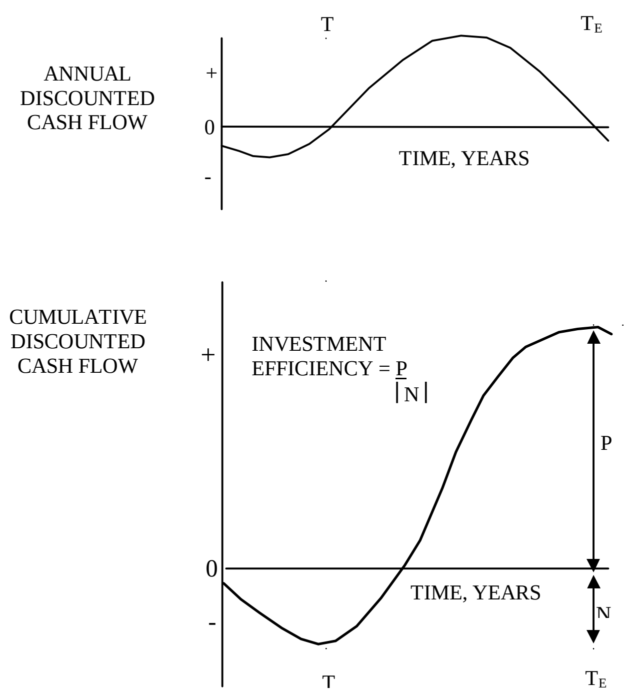
4. Investment Efficiency, the ratio of total DCF to maximum negative DCF.

The strengths and weaknesses of these criteria are discussed in detail by Capen, et al (1976). DCF is the most widely accepted measure of project performance but it fails to recognize capital limitations and requires the specification of a discount rate. If DCF is used, a uniform discount rate should be applied to all cases considered, generally a discount rate based upon the average cost of capital.
DCFROR is a very popular economic criterion, and this measure obviates the need to specify a discount rate as in DCF. Problems with this criterion may result when comparing projects at different discount rates, since a project at a lesser DCFROR may have a greater present value at a company's costs of capital.

The P/I is the ratio of the project's total profit to the total investment required. The P/I recognizes capital limitations and gives a method of ranking projects in such a way as to maximize the profit per dollar invested. However, the sensitivity to cash flow timing is lost. A similar measure to the P/I ratio, the Profit-to-Expense Ratio (P/E), is also computed by the model.

Investment efficiency is defined as the ratio of the maximum cumulative discounted cash flow at economic life (TE in Figure 1.12) to the maximum cumulative negative discounted cash flow (at time T in Figure 1.12). Investment efficiency is an excellent ranking method for enhanced oil recovery projects, which are heavily front-end loaded with high capital and operating expenses. Investment efficiency was the basis for ranking projects used in the 1984 NPC survey.

FIGURE 1.12 -- Investment Efficiency



SECTION 2
IDPM DATA ENTRY

DATA ENTRY AND DEFAULTS

Details of reservoir and economic data entry are given here. A sample listing of input data is given as Table 2-2. This data comprises the base case for the North Riley Unit discussed hirther in Section 6 and Appendix 3a. The output report and plots generated when the IDPM is run on this data are listed in Appendix 3b.

Three types of data are indicated (no blank data allowed):

1. "Required" Data - Program will not run unless a value greater than zero is entered. Required data are API gravity (Card R7), porosity (R9 or R11), permeability (R9 or R11), net pay (R9 or R11), initial water saturation R8), depth (R5), and pattern area (R4).

2. "Default" Data - Enter zero, unless specified otherwise, to default to the value indicated. Values greater than zero are used as specified, unless minimum/maximum bounds are indicated

3. "No Default" Data - Any value entered, including zero, is used as specifiec[

2.1 RESERVOIR DATA

Card R1***** Read Title

READ(IR) TITLE
May be up to 80 alpha-numeric characters.

Card R2 ***** Overall Controls
READ(IR) IARRP, IANALP, ISTRMP, IECONR, NUMTUB, DYKST
IARRP - Controls printing of simulator grid arrays in conjunction with periodic timestep output, which is controlled by IANALP.
= 0 Do not print.
= 1 Do print.
IANALP - Controls printing of simulation information such as initial in-place volumes and periodic (at 0.1 injected pore volume intervals) summaries of production and injection plus, at the end, tables of recovery information for both non-infill and infill.
= 0 Do not print.
= 1 Do print.
ISTRMP - Controls printing of information related to the generation of streamtubes. Higher values cause more detail to be printed.
= 0 Do not print.
= 1 Do print, including numerical depiction of the streamtubes.
= 2 Do print more, including numerical depiction of fmite difference cells within streamtubes and tables of tube/cell volumes, etc.
IECONR - Economics control.
= 0 Do not perform economics.
= 1 Do perform economics
= 2 Perform economics and generate output plots
(No Default)

NUMTUB - Number of streamtubes per layer for both non-infill and infill cases. For quality results, this number should relate to the anisotropy of the reservoir. See table below for defaults, mirlirnums and maximums, depending on VANIS. The reason for maximums is to prevent useless streamtube densities, leading to numerical problems, for highly anisotropic cases. Computing time is proportional to the product of NUMTUB and NX. The print output file displays the current maximum dimensions for NUMTUB

NUMTUB VALUES

VANIS LIMIT	MININUM	DEFAULT	MAXIMUM
2.000	6	12	16
4.000	6	10	14
10.000	4	8	12
20.000	4	6	10
50.000	4	6	8
100.000	4	6	6

DYKST - Dykstra-Parsons VDP value for allocation of layer properties.
<0 Read layer values for porosity, permeability, and thickness for each of ILAYER layers from cards R9 through R9+ILAYER-1. In this case the value of VDP is ignored.
>= 0 Calculate each layer's thickness and permeability, depending on ILAYER, IDYST (Card R10), VKXL, and VHL. When used for this purpose, the value of VDP must be > = 0 and < 1.
(No Default)
Note: If modeling continuity using the "LAYER" method, enter a non-negative value for DYKST.

Card R3 ***** Reservoir Type Data Card 1
READ(IR) IGOIN, ILAYER, NX, VANIS, VKZKH, IPAT9V

IGOIN - infill plug-pack control.
= 1 Do not plug back.
= 2 Do a one-time check for plug-back needs after the first five timesteps of infill simulation. Any layer where water cut exceeds VCUT is shut in (plugged back).
(Default= 1)

ILAYER - Number of layers, including extra layer if using "LAYER" method of modeling continuity. More layers give more realistic results (in theory), particularly at high values of VDP. Computing time is proportional to the number of layers.
(No Default - 5 is a reasonable value)

NX - Number of grid cells per streamtube. More grid cells will give more realistic answers (in theory). Computing time is proportional to the product of NX and NUMTUB.
(Default=15)

VANIS - Ratio of KY to KX.
(Default 1.0)
Note: VANIS is 1.0 or greater.

VKZKH - Ratio of vertical perm to KX.
(Default=0)
(reasonable values range from 0 to *0.5)*

IPAT9V - Infill pattern type.

= 0 5-spot to 5-spot
= 1 5-spot to 9-spot

Card R4 ***** Reservoir Type Data Card 2

READ(IR) VAREA, VDW100, VDBWLS, VCONEC, VRATE, VRATE1, VCUT, CUTMAX, DTMAX

VAREA - Area in acres of flill pattern (8 times the area modelled ifVANIS=l .0; 4 times the area modelled if VANIS <> 1.0). IDPM models the smallest element of symmetry for a pattern (1/8 or 1/4). In the output file, most of the information refers to the element, not the pattern. Thus the reported waterfiood rate is actually 1/8 of the pattern rate (if VANIS=1.0).
(No Default)

VDW 100 - The distance between wells (feet) at which continuity is 1.0. This defines one of two points on the straight line relationship between the log of continuity and the distance between wells (see Figure 1.4).
(No Default)

VDBWLS - The distance between wells (feet) at which VCGNEC (continuity) is entered. VDBWLS should be consistent with VAREA.
(Default=sqrt(21780 * VAREA))

VCONEC - Reservoir connectivity (fraction) at VDBWLS. VCONEC and VDBWLS define one of two points on the straight line relationship between the log of continuity and the distance between wells.
< 0.0 Use the "LAYER" method of modelling continuity (continuity = ABS(VCONEC)). The NXth layer will be used to model the additional pay at infill.
> 0.0 Use the "relative perm" method of modeling continuity. The relative permeability endpoints will be modified to simulate the effects of additional pay.
Note: If the model is run from other than initial conditions, i.e. SOI <(1.0 -SWC), the "LAYER" method must be used to model continuity. (No Default)

VRATE - Non-infill injection rate into total pattern, STB water/day. If VRATE is entered as < 0.0, its absolute value is interpreted as the target oil rate. The injection rate required to achieve this oil rate is calculated using the relative permeability curves. Specifying the oil rate in this fashion is useful when running the model from other than initial conditions (SOI < 1.0 - SWC).
(No Default)

VRATE 1 - Infill injection rate for the entire pattern, STB water/day.
(Default =2 * non-infill injection rate if using the "LAYER" method; Default = injectors are pressure-specified by internal calculation based on pre-infill pressures resulting from pre-infill injection rate if using the SSI method)

VCUT - Water cut at which infill is to occur (Qw/(Qo+Qw))
(No Default)

CUTMAX - Water cut to end each case - both infill and non-infill.
(No Default = VCUT)

DTMAX - Maximum run time, days.
<0 Infill will occur at ABS(DTMAX) days, effectively over-riding VCUT, and both cases will be terminated at CUTMAX.
= 0 Ignored.
> 0 Both the waterflood case and the infill case (if run) will be terminated at DTMAX days, over-riding CUTMAX.

Card R5 ***** Reservoir Geological Data

READ(IR) VCROC, VREFP, VRESP, VTOP, VTEMP

VCROC - Pore volume compressibility, VOL/VOL/PSI.
(Default = 3.0 E-6)

VREFP - Pressure at which porosity and oil and water densities are entered, PSIA. If VREFP is not equal to VRESP, porosity is adjusted to reservoir conditions using VCROC.
(Default = VRESP)

VRESP - Reservoir pressure at top of formation.
(Default 15. - VTOP * 0.433)

VTOP - Depth to top of reservoir, feet.
(No Default)
Note: Value is entered as negative.

VTEMP - Reservoir temperature, degrees F.
(Default =60. - VTOP * 0.017)

Card R6 ***** Water Properties

READ(IR) DENWST, BWI, CMPWTR VISWTR SGGV

DENWST - Water density at standard conditions, LBM/FT^3.
(Default = 62.4 LBM/FT^3)

BWI - Water formation volume factor at VTEMP and VRESP.
(Default BWI = 1.0 + 1.2E - 4 * (VTEMP - 60) + 1.0E - 6 * (VTEMP -60)**2 - 3.33 E-6 * VRESP)

CMPWTR - Water compressibility at reservoir conditions VOL/VOL/PSI.
(Default = 3.0 E-6)

VISWTR - Water viscosity, cp.
(Default = -1.439 * ALOG10 (VTEMP) + 3.74486)

SGGV - Gas gravity, AIR = 1.0. Used in GOR and oil density correlations, see discussion that follows Input.
(Default = 0.8 * (1.0 + 5.915 E-5 * API * VTEMP * ALOG (64.7/114.7))

Card R7 ***** Oil Properties

READ(IR) APIV, BOI, CMPOIL, VISOIL, GORV

APIV - API gravity for the reservoir oil at hand.
(No Default)

BOI - Oil formation volume factor at VTEMP and VRESP.
(For default see following discussions.)

CMPOIL - Oil compressibility at reservoir conditions VOL/VOL/PSI.
(Default = 3.0 E-6)

VISOIL - Oil viscosity, cp.
(For default see following discussion.)

GORV - Solution GOR, SCF/STB used for economics only.
(For default see following discussion.)

Card R8 ***** Relative Permeability Data at VCONEC=1.0

READ(IR) VXNO, VXNW, VXKROE, VXKRWE, VSWC, VSORW, SOI

VXNO - Oil relative permeability curve exponent, fraction.
(Default = 2.0)

VXNW - Water relative permeability curve exponent, fraction.
(Default = 2.0)

VXKROE - Oil relative permeability at, VSWC, fraction.
(Default = 0.80)

VXKRWE - Water relative permeability at VSORN, fraction.
(Default = 0.20)

VSWC - Connate water saturation, fraction.
(Default = 0.2)

VSORW - Residual oil saturation to a waterflood, fraction.
(Default = 0.25)

SOI - Initial oil saturation override (fraction). This is used if the model is run from an oil saturation other than 1.-VSWC. Must be greater than VSORW and less than or equal to 1.-VSWC. May be zero, in which case SOI (1.-VSWC).

Card R9 ***** R9 + ILAYER - Layer Properties

If DYKST > 0 skip these cards and go to cards R10 and R11.

READ(IR) VPHI(I), VKX(I), VH1(I)

VPHI(I) - Porosity of Layer I, fraction.
(No Default)

VKX(I) - X-direction of permeability of Layer I, MD.
(No Default)

VH1(I) - Net pay of Layer I, feet.
(No Default)
Note: One card for each of the layers, 1 through ILAYER.

Card R10 ***** Dykstra-Parsons Calculation Type only read if DYKST > 0

READ(IR) IDYST

IDYST - = 1 Calculate layer K and H on basis of equal thickness per layer.
= 2 Calculate layer K and H with equal KH per layer.
(No Default)
Note: Set to I if using the "LAYER" method (option 2 not tested)

Card R11 ***** Average Layer Properties (only read if DYKST> 0)

READ(IR) VPHIL, VKXL, VHL

VPHIL - Average porosity for all layers, fraction.
(No Default)

VKXL - Average x-direction permeability, md.
(No Default)

VHL - Total net pay, feet.
(No Default)

2.2 ECONOMIC DATA

The following cards are to be read if IECONR>0 on Card R2, one set for non-infill, one set for infill, one set for incremental.

Card E1 ***** Read Economic Title

Read(IR) TITLE

TITLE - May be up to 80 alpha-numeric characters.

Card E2 ***** Read Case Controls

READ(IR) M, ISTATE, IDIST, IOUT, IFIT, IDAT, NCT, NCI, IDISC, ISO, IPLIF, IDEBT

M - Number of years in the project (for all patterns). M must be <=50.

ISTATE - State code. Used to default well capital costs (drilling, completion, conversion, upgrading) by region of U.S. See Section 3.2 for explanation of defaults by region. To invoke defaults for well capital costs, enter the appropriate number 1-52 from Table 2-1. If ISTATE = 1-52 on this card, then the model penalizes oil price based on API gravity and location. See Section 3.2 for explanation of penalties. If the project is outside the U.S. or it is desired to disable oil price penalty, enter ISTATE=53 on this card.

TABLE 2-1
SUMMARY OF STATE CODES

CODE	ALPHA	STATE	CODE	ALPHA	STATE
1	AL	ALABAMA	27	NV	NEVADA
2	AZ	ARIZONA	28	NH	NEW HAMPSHIRE
3	AR	ARKANSAS	29	NJ	NEW JERSEY
4	CA	CALIFORNIA	30	NM	NEW MEXICO
5	CO	COLORADO	31	NY	NEW YORK
6	CT	CONNECTICUT	32	NC	N. CAROLINA
7	DE	DELAWARE	33	ND	N. DAKOTA
8	DC	WASH D.C.	34	OH	OHIO
9	FL	FLORIDA	35	OK	OKLAHOMA
10	GA	GEORGIA	36	OR	OREGON
11	ID	IDAHO	37	PA	PENNSYLVANIA
12	IL	ILLINOIS	38	RI	RHODE ISLAND
13	IN	INDIANA	39	SC	S. CAROLINA
14	IA	IOWA	40	SD	S. DAKOTA
15	KS	KANSAS	41	TN	TENNESSEE
16	KY	KENTUCKY	42	TX	TEXAS
17	LA	LOUISIANA	43	UT	UTAH
18	ME	MAINE	44	VT	VERMONT
19	MD	MARYLAND	45	VA	VIRGINIA
20	MA	MASS	46	WA	WASHINGTON
21	MI	MICHIGAN	47	WV	WEST VIRGINIA
22	MN	MINNESOTA	48	WI	WISCONSIN
23	MS	MISSISSIPPI	49	WY	WYOMING
24	MO	MISSOURI	50	AK	ALASKA
25	MT	MONTANA	51	HI	HAWAII
26	NE	NEBRASKA	52	P0	OFFSHORE

IDIST - District code (within a state). Used to default well costs. If outside U.S. or if ISTATE=53, Enter IDIST=0. For Texas Railroad Commission (RRC) districts, enter (RRC NO. * 10) + Y, where

Y = 1 for A
= 2 for B
= 3 for C

e.g., for district 10B enter 102, etc.

IOUT - Controls printing of economic calculations (no default, see Table 2-2 and Section 4.1)
= 0, Minimum output, prints economic summary
= 1, Also prints annual cash flow, project capital schedule, and undiscounted results
= 2, Also prints escalated values of prices and costs

IFIT - Federal income tax credit option (no default)
= 0, Allows a tax credit to offset losses
= 1, No tax credit allowed

IDAT - Control for reading price and cost data
= 0, Default prices and costs used, skip Cards E10-E13; see E10-E13 for default values
= 1, Read Cards E10-E13 for price and cost data

NCT - Control for reading tangible capital investment per pattern in any given year. Investments will be timed according to the pattern schedule on Card E9.
= 0, Do not read tangible capital investment on Card E14, accept default

= 1, Read tangible capital investment on Card E14

NCI - Control for reading intangible capital investment per pattern in any given year. Investments will be timed according to pattern schedule on Card E9.
= 0, Do not read intangible capital investment on Card E15, accept default
= 1, Read intangible capital investment on Card E15

IDISC - Control for discounting method
= 0, Year end discounting factors used
= 1, Mid-year discounting factors used
(No Default)

ISO - Control for reading secondary oil volume
= 0, Do not read secondary oil volumes
= 1, Read secondary oil volumes
(No Default)

IPLIF - Control on economic life
= 0, Economic life based on after tax cash flow
= 1, Economic life based on net operating income
(No Default)

IDEBT - Control on debt calculations
= 0, No capital borrowing debt calculations
= 1, Include capital borrowing based on data input on Card E3
(No Default)

Card E3 ***** Read Debt Controls
(Read if IDEBT = 1 on Card E2)

READ(IR) PCTDBT, DBTINT, NYRRPY, NYPAID

PCTDBT - percent of capital (tangible and intangible) costs to be borrowed, percent (default=20.)

DBTINT - Debt interest rate, percent (default=15.)

NYRRPY - Number of years before beginning debt repayment (default=1.)

NYPAID - Number of years before completing debt repayment (default=5.)

Card E4 ***** Read Operating and Plant Capital Data

Capital for plants (CCHM, CWAT) on this card will be taken in the first year of the project and will be added to capital for wells (if any), whether latter capital is defaulted on Card E2 or read on Cards E14-E15.

READ(IR) CWAT, CWCAP, WOCOST, WTCOST

CWAT - Capital for water injection plant, M$ (no default; estimate is 40.0 * RMAX M$.)

CWCAP - Capacity of water injection plant, MMB/YR
(Default: CWCAP=365.*RMAX/1000.0)

WOCOST - Annual well workover cost per pattern, M$.
(Default: 0.25*CNVT. Assumes one workover per pattern every four years. CNVT is the cost to convert an existing producer to an injection well. See Section 3.2 for default for CNVT.

WTCOST - Produced water treating costs, $/BBL (default=0.03)

Card E5 ***** Read Operating Data
READ(IR) WCAP, UNCO, COSTRT

WCAP - Months of working capital, months
(No Default)

UNCO - Oil rate uncertainty, fraction
(Default=0.001)

COSTRT - Project startup costs, MS
(No Default; the negative of COSTRT is used to initialize cash flow)

Card E6 ***** Read Taxes and Monetary Data
READ(IR) XDR, XINF, XROY, XSEV, XFIT, XTCR, DTIM, XSTX

XDR - Monetary discount rate
(Default = 0.1)

XINF - Inflation rate
(No Default)

XROY - Royalty rate
(No Default)

XSEV - Severance tax rate
(No Default)

XFIT - Federal income tax rate
(No Default)

XTCR - Investment tax credit
(No Default)

DTIM - Investment depreciation time, yr. If DTIM = 0.0, the model uses accelerated capital recovery system (8 yr depreciation) according to 1986-1987 tax act. If DTIM>. 0.0, uses straight line depreciation from year of investment over DTIM years.
(No Default)

XSTX - State income tax rate
(No Default)

Card E7 ***** Read Windfall Excise (Profit) Tax Data
READ (IR) XWPT, WPHO, EPHO, BTIM, BPOW

XWPT - Windfall excise tax rate. If 0.0 then ignores tax. See Section 3.2 for explanation of windfall excise tax.

WPHO - Windfall tax beginning phase out date.
(Default= 1991)

EPHO - Windfall tax ending phase out date.
(Default= 1993)

BTIM - Base time for project start.
(Default = 1994)

BPOW - Base oil price at start of project for WPT calculations only, $/BBL
(Default= 23 .07*(1 .+XINF)**(BTIM- 1983.)
Note: Oil Price for sales and revenue purposes is entered or defaulted on Card E10.

Card E8 ***** Read Escalation Data for Prices and Costs
READ(IR) ESCPO, ESCPG, ESCFO, ESCWT, ESCWI, ESCWO

ESCPO - Escalation rate of oil price
(No Default)

ESCPG - Escalation rate of gas price
(No Default)

ESCFO - Escalation rate of operating costs
(No Default)

ESCWT - Escalation rate of tangible capital
(No Default)

ESCWI - Escalation rate of intangible capital
(No Default)

ESCWO - Escalation rate of well workover cost
(No Default)

Card E9 ***** Read Project Pattern Schedule

READ(IR) (PATI(I),I= 1 ,M)

PATI(I) - Number of patterns initiated each year of the project
(No Default)

IF IDAT=0 on Card E2, model uses default prices and costs; skip to Card E14.

In the names of all of the following arrays, the last letter (H, M, or L) means high, most likely, or low value of the parameter in a given year. The high and low values should be chosen to represent a confidence level of 80 percent. Low price has a 90% chance of being obtained, and the high price has only a 10% chance of being reached. See Section 1.9 for discussion of risk.

Prices and costs, whether entered or defaulted, are scaled by program (subroutine ECFTR) due to variation in oil price from $30.00/BBL. The price factor is FACT=(POM(1)-30.00)/30., where POM(1) is entered or defaulted on Card E10. Then:

Drilling and completion factor = 1.0 +(0.4 * FACT)
Equipment factor = 1.0 +(0.3 * FACT)
Operating costs factor = 1.0 +(0.2 * FACT)
Polymer price factor = 1.0 + (0.3913 * FACT)
Oil price factor = 1.0 + FACT

Card E10 ***** Read Oil Price Data

READ(IR) POL(1), POM(1), POH(1)

POL(1) - Low oil price, $/BBL (default = POM(1) * 0.8)

POM(1) - Most likely oil price, $/BBL (default = 30.00. This read or defaulted oil price may subsequently be reduced based on API gravity and location. See Section 3.2 for discussion of oil price penalties.)

POH(1) - High oil price, $/BBL (default = POM(1) * 1.2)

Card E11 ***** Read Gas Price Data

READ(IR) PGL(1), PGM(1), PGH(1)

PGL(1) - Low gas price, $/MSCF
(Default = PGM(1)*0.8)

PGM(1) - Most likely gas price, $/MSCF
(Default = POM(1)/6.0)

POH(1) - High gas price, $/MSCF
(Default = PGM(1)* 1.2)

Card E12 ***** Read Fixed Annual Operating Cost Data

Includes maintenance, other costs that do not depend on oil rate. For incremental case, fixed operating costs are set to zero until waterflood life exceeded.)

READ(IR) FOCL(1), FOCM(1), FOCH(1)

FOCL(1) - Low fixed operating cost per pattern, $/yr
(Default: FOCL(1)=(CDAO+CIWO) *0.8, where CDAO (operating costs for SEC recovery) and CIWO (additional operating costs for offshore water injection Plant) are defaulted in Section 3.2).

FOCM(1) - Most likely fixed operating cost per pattern, $/yr.
(Default: FOCM(1)=(CDAO+CIWO))

FOCH(1) - High fixed operating cost per pattern, $/yr.

(Default: FOCH(1)=(CDAO+CIWO)*1.2)

Card E13 ***** Read Variable Annual Operating Cost Data

(Includes lifting and other costs that depend on oil production directly, but not royalty or severance.)

READ(IR) OPCL(1), OPCM(1), OPCH(1)

OPCL(1) - Low variable operating cost, $/BBL oil produced.
(Default = 0.04)

OPCM(1) - Most likely variable operating cost, $/BBL oil produced.
(Default = 0.05)

OPCH(1) - High variable operating cost, $/BBL oil produced.
(Default = 0.06)

Card E14 ***** Read Tangible Capital Investment (Read if NCT=1 on Card E2)

(Flow lines, wells, roads, and production facilities.)

If well entered on Card E4, do not enter well capital costs on this card.

READ(IR) ICT, CTPL, CTPM, CTPH

ICT - Enter 1.0

CTPL - Low tangible capital cost per pattern, $.
(No Default)

CTPM - Most likely tangible capital cost per pattern, $.
(No Default)

CTPH - High tangible capital cost per pattern, $.
(No Default)

Card E15 ***** Read Intangible Capital Investment (Read if NCI=1 on Card E2)

(Capital expensed in a given year.) If wells entered on Card E4, do not enter well capital costs on this card.

READ(IR) ICI, CIPL, CIPM, CIPH

ICI - Enter 1.0

CIPL - Low intangible capital cost per pattern, $.
(No Default)

CIPM - Most likely intangible capital cost per pattern, $.
(No Default)

CIPH - High intangible capital cost per pattern, $.
(No Default)

Card E16 ***** Read END Card

READ (IR) END

END - “END" in columns 14.

***** RETURN TO CARD E1 FOR NEW CASE *****

TABLE 2-2 -- SAMPLE INPUT DATA

```
IDPM Sensitivity Analysis: North Riley Unit Base Case
0, 1, 1, 2, 0, 0.83
1, 11, 15, 1., 0.10, 0
40., 300., 933., 55, 200., 400., .75, 0.95, 0.
.000003, 3000., 2750., -6300., 107.
64.00, 0.0, .000003, .6, 0.8
32.00, 1.28, .00000735, 1.7, 330.
2., 2., .752, .40, .32, .25, 0.
1
0.0800, 10., 400.
Economics for Waterflood
40, 53, 0, 2, 0, 1, 0, 0, 0, 0, 0, 0
0.0, 0.0, 0.0, 0.03
0.0, 0.001, 0.0
0.1, 0.05, 0.125, 0.08, 0.46, 0.1, 5.0, 0.04
0.0, 0.0, 0.0, 0.0, 23.07
0.0, 0.0, 0.0, 0.0, 0.0, 0.0
6.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
16.00, 20.00, 24.00
2.67, 3.33, 4.00
33313., 41642., 49970.
.04, .05, .06
Economics for Infill Waterflood
40, 53, 0, 2, 0, 1, 0, 0, 0, 0, 0, 0
0.0, 0.0, 0.0, 0.03
0.0, 0.001, 0.0
0.1, 0.05, 0.125, 0.08, 0.46, 0.1, 5.0, 0.04
0.0, 0.0, 0.0, 0.0, 23.07
0.0, 0.0, 0.0, 0.0, 0.0, 0.0
6.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
16.00, 20.00, 24.00
2.67, 3.33, 4.00
33313., 41642., 49970.
.04, .05, .06
Economics for Infill over Non-Infill
40, 53, 0, 2, 0, 1, 0, 0, 0, 0, 0, 0
0.0, 0.0, 0.0, 0.03
0.0, 0.001, 0.0
0.1, 0.05, 0.125, 0.08, 0.46, 0.1, 5.0, 0.04
0.0, 0.0, 0.0, 0.0, 23.07
0.0, 0.0, 0.0, 0.0, 0.0, 0.0
6.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
16.00, 20.00, 24.00
2.67, 3.33, 4.00
33313., 41642., 49970.
.04, .05, .06
END
```

SECTION 3
DEFAULT EQUATIONS

In Section 2, default values are documented for the input parameters, where applicable. In many cases, it is not sensible to use a single default value because there must be physical (and/or economic) consistency between certain parameter values. For those cases, the software contains built-in relationships, or equations, which are used to compute default values. This section discusses those equations.

3.1 RESERVOIR DATA

Oil Viscosity

Oil viscosity is defaulted according to API gravity and GOR (see discussion below for GOR default) using the correlation of Beggs and Robinson (1975). The model first calculates the dead oil viscosity, VISD (cp).

VISD = 10.0**X-1,

where

X = Y/TEMP**1.163,
Y = 10.0**Z,
Z = 3.0324-0.02023*API,

and TEMP is the reservoir temperature, degrees F (card *R5).* Then the live oil viscosity is

VISO = A*VISD**B,

where

A = 10.715/(GOR+100.0)**0.515

and

B = 5.44/(GOR+150.0)**0.338.

Solution Gas-Oil Ratio

Solution gas-oil ratio, GOR, is defaulted by API gravity (Vasquez and Beggs, 1980). These correlations appear to give low values for heavy crude oils. The model first corrects the gas gravity, SGG, as input or defaulted on card R6 to a 100 psig separator condition, assuming the separator is at TEMP:

SGG = SGG*(1.0+5.912E-5*API*TEMP*ALOG (64.7/114.7)).

SGG calculated from Eq. (3.3) is bounded by 0.8 and 1.4.

Then for API≤0, in SCF/STB

GOR = 0.0362*SGG*(PFORM** 1.0937)*EXP(25.724*(API/(TEMP+460.))),

and for API>30,

GOR = 0.0178*SGG*(1)PFORM**1.187)* EXP(23.931 *(API/(TEMP+460.))).

Oil Formation Volume Factor

Oil formation volume factor is defaulted according to API gravity Vasquez and Beggs, 1980). This is used to calculate the standard density of oil.

B0 = 1.0+C1*GOR+(C2+C3*GOR)*(TEMP-60)*(API/SGG),

where for API≤30.,

C1 = 4.677E-4
C2 = 1.751E-5
C3 = -1.811E-8

and for API>30.,

C1 = 4.67E-4
C2 = 1.1E-5
C3 = 1.337E-9.

3.2 ECONOMIC DATA

IDPM Treatment of Well Capital Costs

Well tangible (WCT and intangible (WCI) capital costs are calculated as follows. The total well capital is

CAP = (CINJ*WPP1)+(CINJ+CEQP)*WPP2 + CSEC*WPP3+CNVT*WPP4+CREP,

where the WPP's are read and the CINJ, etc. are defined below. Per pattern

WCT = 0.28*(CEQP*WPP2+CSEC*WPP3),

and

WCI = CAP-WCT.

The total project intangible capital is obtained by summing the WCI over the number of patterns. A similar calculation is performed for the total project tangible capital, CTCM(I), except that the capital for water injection (CWAT) plants are included in year one of the project

CTCM(I) = WCT+CWAT.

CWAT can also be defaulted

The well capital and operating costs defaults given below were derived from correlations from the DOE/EIA-0185(82) report, "Casts and Indexes for Domestic Oil and Gas Field Equipment and Production Operations, 1990" scheduled for publication in the spring of 1994.

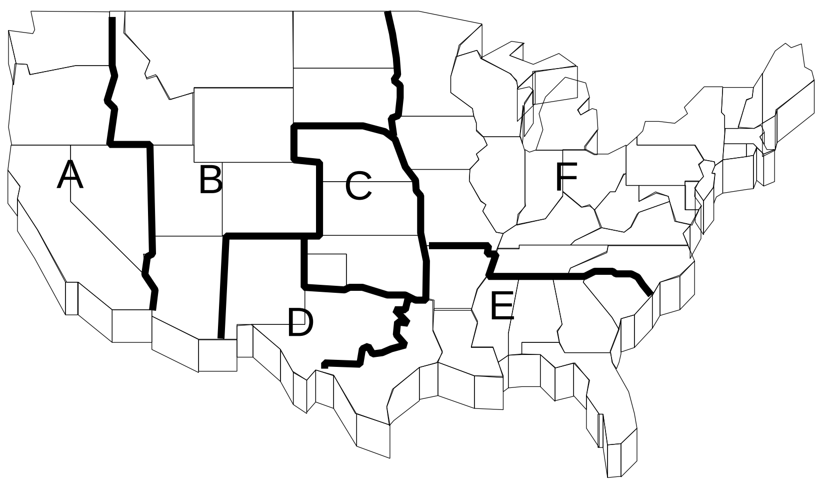
Drilling and Completion Costs

These costs (CINJ) include the cost of drilling and completing through the wellhead, including tubing, and are used to represent the cost of new injection wells. New producing wells have additional equipment costs which are discussed below. CINJ is defaulted according to depth and region of the U.S. (Figure 3-1). In $/ well,

CINJ = A0 + A1*DEPTH**2,

where A0-A 1 are shown in Table 3 - 1.

FIGURE 3-1 -- Regions for Drilling and Completion Costs



A--Pacific Coast	B--Rocky Mountains	C--Mid-Continent
D--Permian Basin	E--Gulf Coast	F--Northeastern

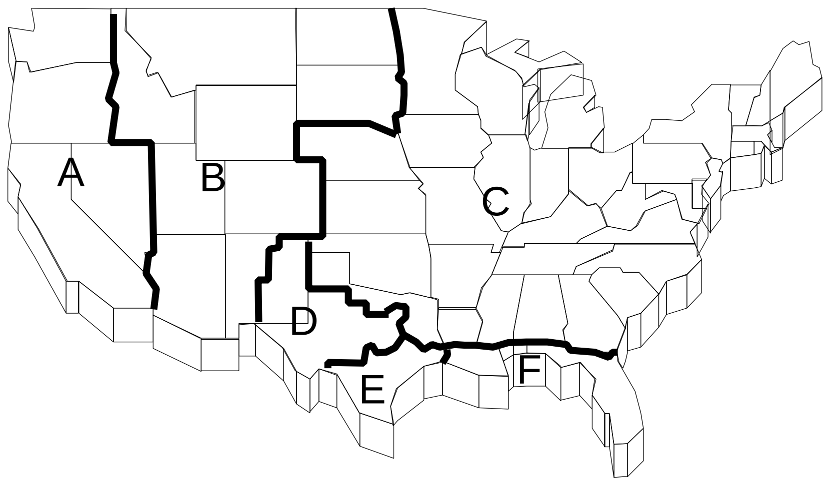
Costs to Equip New Producing Well

These costs (CEQP) consist of all costs to equip a new producing well for secondary recovery, excluding costs for tubing. CEQP is defaulted according to depth and region of the U.S. (Figure 3-2). In $/ producing well,

CEQP = B0+B1*DEPTH,

where B0 and B1 are shown in Table 3-2.

FIGURE 3-2
Regions for Equipment, Conversion, and Operating Costs and Secondary Facilities



A--Pacific Coast	B--Rocky Mountains	C--Mid-Continent & Northeastern
D--Permian Basin	E--Western Gulf Coast	F--Eastern Gulf Coast

Costs of Additional Secondary Production Equipment for a Primary Well Converted to a Secondary Well

For these costs (CSEC), it is assumed that the existing processing and lease facilities are not replaced, old producing well equipment is replaced, and that costs for drilling and equipping water supply wells are included. CSEC is defaulted according to depth and region of the U.S. In $/well,

CSEC = C0+C1 *DEPTH,

where C0 and C1 are shown in Table 3-3.

Costs to Convert a Producing Well to an Injection Well

These costs (CNVT) include removal of producing equipment and tubing, acidizing and cleaning out the wellbore, and installing new plastic coated tubing and a waterflood packer. CNVT is defaulted by depth and region of the U.S. In $/ well,

CNVT = E0+E1*DEPTH,

where E0 and E1 are shown in Table 3-4.

Costs To Upgrade Surface Processing Equipment and Lease Facilities For Secondary Recovery Operations

These costs (CREP) include flowlines, manifolds, separators, treaters, tanks, LACT unit, disposal system and accessories. CREP is defaulted by depth and region of the U.S. In $/ producing well,

CREP = F0+F1*DEPTH**2,

where F0-F1 are shown in Table 3-5. If WPP4=0, then the model sets CREP=0.

Direct Annual Operating Costs for Secondary Recovery Operations

These costs (CDAO) include all costs essential to the production of oil and gas, such as cost of labor, power, equipment repair and maintenance, fluid injection, treatment of oil and gas, etc. CDAO is defaulted according to depth and region of the U.S. In $/ producing well/year,

CDAO = G0+G1*DEPTH,

where G0 and G1 are shown in Table 3-6. CDAO is used to default fixed annual operating costs.

Costs for Offshore Operations

Defaults for these costs are as follows (use ISTATE=52 for offshore):

```
CINJ  =  458492.-56327l*DEPTH+0.03043*DEPTH**2, $/well
CEQP  =  0.0
CSEC  =  650000.+230000.*RATE-2800.*RATE**2, $/well
```

where RATE is the maximum water injection rate calculated by the model.

```
CNVT  =  171366.+21.825*DEPTH, $/well,
CREP  =  0.0
CDAO  =  $169,000/well/yr.
```

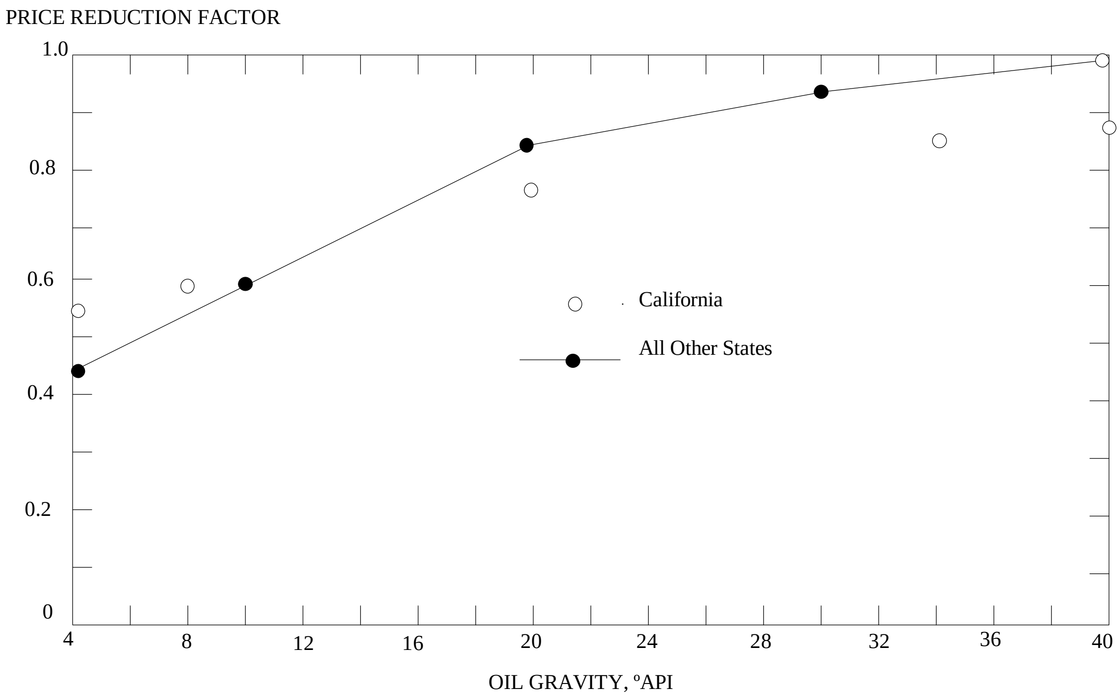
Oil Price Penalties

The read-in (or defaulted) oil price (card E10) is penalized for API gravities less than 40 according to location. Figure 3-3 shows the multiplicative price reduction factors as a function of gravity for California (ISTATE=4) and for all other states. The latter curve in Figure 3-3 is based on mid-continent posted prices (NPC, 1984).

For projects in Alaska (ISTATE=50) oil is priced in accordance with the solid curve of Figure 3-3 less another $9.00/bbl for transportation fees. These fees are associated with amortized capital, port of entry charges, and fixed tariffs and do not vary with oil price.

If ISTATE=53, then the API gravity penalty is disabled and the price reduction factor is 1.0 regardless of the value of API input. This feature was added to the model for projects outside the U.S., where different oil pricing scenarios may apply.

Figure 3-3 -- Oil Price Reduction Factors



Windfall Profit Tax

The Windfall Profit Tax (WPT) effected by statute in 1980 is an excise tax on U.S. crude oil production. The WPT is applied as a percentage of the difference between the sales price of oil (POM(I) adjusted for API gravity and location) and a base price (BPOW or BPO(I)), that escalates with time. The base price varies with crude oil production method and field history.

The WPT tax rate (XWPT), also varies with production method and type of producer (major or independent). XWPT for heavy oil and/or incremental tertiary oil is 30% for majors, and 0% up to 1,000 bpd (30% over 1,000 bpd) for independents (see Table 3-7). Definitions of Tier 1 and tier 2 oil in Table 3-7 are quite complex, and may be found in "The Crude Oil Windfall Profit Tax," Price-Waterhouse, 1980.

In the PFPM, the WPT is calculated from

WPT(I) = VONET(I)*(1.-XSEV)*AWPP(I)*XWPT,

where

VONET(I)	=	net oil sold (less royalty), BBL
XSEV	=	severance tax rate
AWPP(I)	=	sales price - BPO(I), $/BBL.

In the IDPM there is no WPT for API gravities of 16.0 or less.

TABLE 3-1
COEFFICIENTS FOR DRILLING AND COMPLETION COSTS

REGION (Fig. 3-1)	A0	A1
Pacific Coast	91.186	1.760E-5
Rocky Mountain	108.451	8.471E-6
Permian Basin[1]	71.736	6.433E-6
Gulf Coast[2]	57.833	9.201E-6
Mid-Continent[3]	69.634	5.967E-6
Northeastern	61.109	4.230E-6

[1] Includes Texas RRC Districts 7-9.
[2] Includes Texas RRC Districts 1-6.
[3] Includes Texas RRC District 10.

TABLE 3-2
COEFFICIENTS FOR COSTS TO EQUIP NEW PRODUCING WELL

REGION (Fig. 3-2)	B0	B1
Permian Basin	20347.0	17.165
Pacific Coast	25668.0	26.038
Rocky Mountains[1]	17504.0	18.069
Western Gulf Coast[2]	20810.0	17.331
Eastern Gulf Coast[3]	20266.0	17.130
Mid-Continent and Northeastern[4]	17706.0	17.833

[1] Includes New Mexico District 1.
[2] Includes Texas RRC Districts 1-3.
[3] Includes Florida, and Louisiana District 2.
[4] Includes Texas RRC District 9.

TABLE 3-3
COEFFICIENTS FOR COSTS OF ADDITIONAL SECONDARY PRODUCTION EQUIPMENT

REGION (Fig. 3-2)	CO	C1
Permian Basin	18997.0	19.927
Pacific Coast	23234.0	30.193
Rocky Mountains[1]	15792.0	20.950
Western Gulf Coast[2]	19466.0	20.122
Eastern Gulf Coast[3]	18916.0	19.887
Mid-Continent and Northeastern[4]	16048.0	20.680

[1] Includes New Mexico District 1.
[2] Includes Texas RRC Districts 1-3.
[3] Includes Florida, and Louisiana District 2
[4] Includes Texas RRC District 9.

TABLE 3-4
COEFFICIENTS FOR COSTS TO CONVERT PRODUCING WELL TO INJECTION WELL

REGION (Fig 3-2)	E0	E1
Permian Basin	6086.0	6.661
Pacific Coast	7713.0	6.741
Rocky Mountains[1]	6951.0	6.805
Western Gulf Coast[2]	6326.0	6.596
Eastern Gulf Coast[3]	6996.0	6.628
Mid-Continent and Northeastern[4]	6741.0	6.559

[1] Includes New Mexico District 1.
[2] Includes Texas RRC Districts 1-3.
[3] Includes Florida, and Louisiana District 2.
[4] Includes Texas RRC District 9.

TABLE 3-5
COEFFICIENTS FOR COSTS TO UPGRADE SURFACE PROCESSING EQUIPMENT

REGION (Fig. 3-2)	F0	F1
Permian Basin	22323.0	2.009E-4
Pacific Coast	47322.0	2.717E-4
Rocky Mountains[1]	31543.0	1.685E-4
Western Gulf Coast[2]	31067.0	3.327E-4
Eastern Gulf Coast[3]	34617.0	3.442E-4
Mid-Continent and Northeastern[4]	24688.0	2.426E-4

[1] Includes New Mexico District 1.
[2] Includes Texas RRC Districts 1-3.
[3] Includes Florida, and Louisiana District 2.
[4] Includes Texas RRC District 9.

TABLE 3-6
COEFFICIENTS FOR DIRECT ANNUAL OPERATING COSTS

REGION (Fig. 3-2)	G0	G1
Permian Basin	17759.0	4.801
Pacific Coast	9948.0	11.917
Rocky Mountains[1]	18894.0	4.932
Western Gulf Coast[2]	21214.0	5.677
Eastern Gulf Coast[3]	22461.0	5.904
Mid-Continent and Northeastern[4]	8539.0	6.473

[1] Includes New Mexico District 1.
[2] Includes Texas RRC Districts 1-3.
[3] Includes Florida, and Louisiana Districts 2.
[4] Includes Texas RRC District 9.

TABLE 3-7
WINDFALL PROFIT TAX RATES

	TAX RATE. %		
	MAJOR	**INDEPENDENT**	
		<1000 bpd	**>1000bpd**
Tier 1			
Lower Tier Oil	70	50	70
Upper Tier Oil	70	50	70
Market Level New Crude Oil	70	50	70
Marginal Well Oil	70	50	70
Tier 2			
Stripper Well Oil	60	30	60
National Petroleum Reserve Oil	60	30	60
Tier 3			
Newly-Discovered Oil	30	0	30
Heavy Oil	30	0	30
Incremental Tertiary Oil	30	0	30

SECTION 4
IDPM VERIFICATION AGAINST BLACK-OIL SIMULATION

IDPM results were verified against SSI's SimBest II black-oil simulator. SimBest II does not allow relative permeability to change with time. In the IDPM, however, different relative permeability curves are calculated for the pre-infill and post-infill time periods because of improving connectivity.

In order to avoid possible discrepancies between IDPM and SimBest II results, the verification test case needed to have similar connectivity values for pre-infill and post-in-fill time periods. As a result, calculated IDPM relative permeability curves for both time periods would be very similar to each other, and this would allow input of only one relative permeability curve into SimBest II.

As Figure 1.10 in Section 1 illustrates, the higher the connectivity value at pre-infill conditions, the more horizontal the curve, and thus, the less change in connectivity as well spacing is reduced. Therefore, for this verification test, the IDPM was assigned a high initial connectivity value of .95 at 40 acre well spacing (80 acre 5-spot). Reducing the well spacing to 20 acres, increased the connectivity to .969 with slight changes in the relative permeability curves, but not enough to significantly effect comparison with SimBest II results.

The IDPM input for the verification test was as follows:

Dykstra-Parsons coefficient, Vdp = .83
No Plug Backs
4 Layers
K = .65 md
Ky/Kx = 1
Kz/Kx = .01
5-spot (pre-infill) to 9-spot (infill)
80 acre non infill pattern area
Connectivity, C = .95 (at 1320 ft well spacing)
Non infill injection rate = 200 STBW/Day
Infill injection rate = 400 STBW/Day
Water cut at infill, fw = .60
Water cut at economic limit, fwe = .90
Viscosity ratio, uo/uw = 2

For a more detailed listing of all parameters see the IDPM input and output for this case in Appendix 1a.

The same input parameters used in the IDPM run were used in the SimBest II decks. A 5 x 5 x 4 water-oil model was constructed, and pore volumes, transmissibilities, and kh values were reduced appropriately to simulate 1/8 of a 5-spot. Relative permeability curves were input directly from IDPM output for connectivity equal to .95. PVT values were obtained from correlations within SSI's Well Productivity Model (WPM).

The SimBest II input deck, simulation run deck, and timestep summary for this case are included in Appendix 1b. Each well was completed in all four layers. Rates were specified for each well. For the pre-infill time period (1 to 6,450 days), the injector rate was specified to be 25 STBW/Day with a bottomhole pressure constraint of 4,550 psi. The non-infill producer rate specification was 20 STBO/Day with a bottomhole pressure constraint of 100 psi. For the post-infill time period (6,450 to 17,600 days), the injector rate specification was increased to 50 STBW/Day. The non-infill producer rate specification was decreased to 10 STBO/Day, and the infill producer rate specification was 15 STBO/Day.

Figure 4.1 shows oil rate over time obtained from the IDPM as compared to SimBest II oil rate. Both IDPM and SimBest results are for 1/8 of the original 5-spot pattern. The results compare well. For the pre-infill time period, IDPM oil rate and SimBest oil rate are almost exact. At the time of infill (6,450 days), both IDPM and SimBest II calculate sharp increases in oil rate. Following infill, the oil rate calculated by SimBest II is above that calculated by IDPM, but the curve trend is identical.

Figure 4.1
IDPM Verification Against Black-Oil Simulation (SSI's SimBest II) Oil Rate 1/8 5-Spot

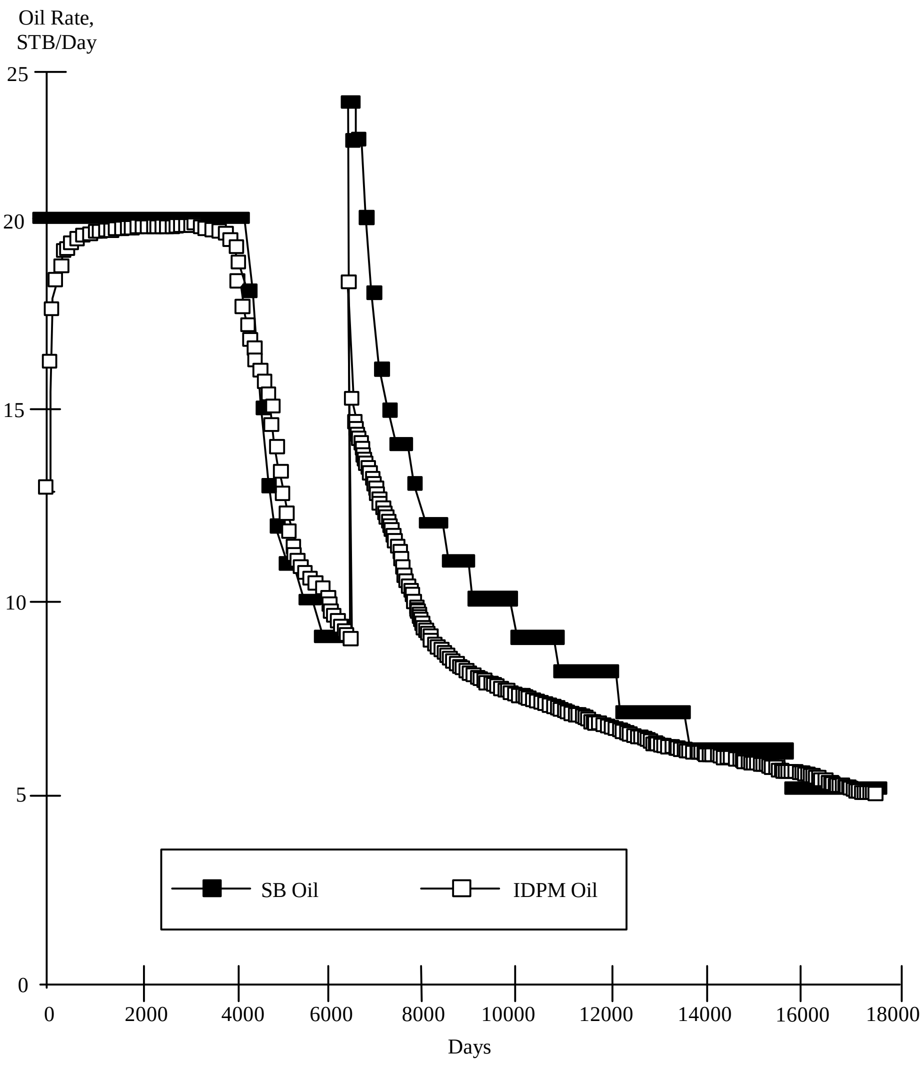
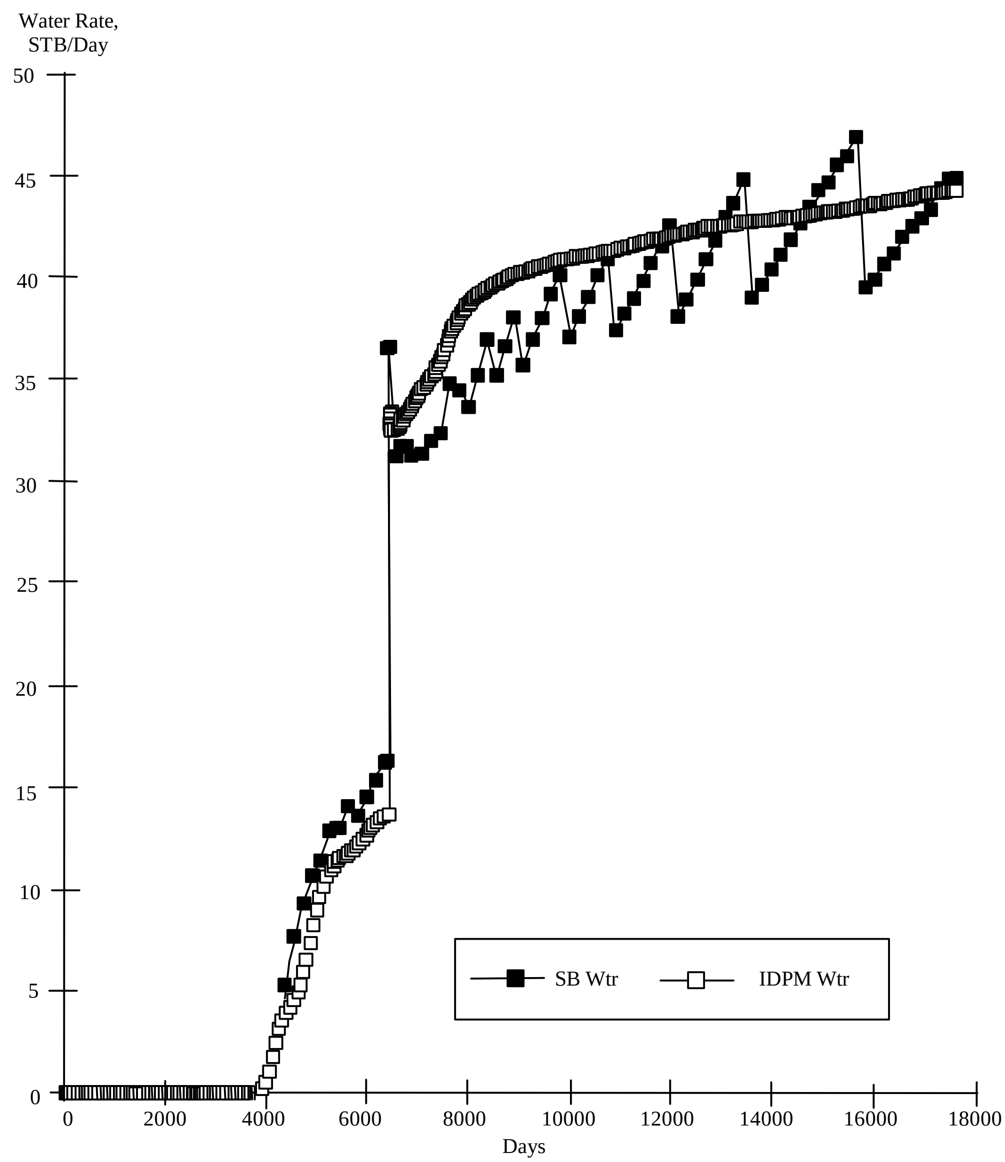


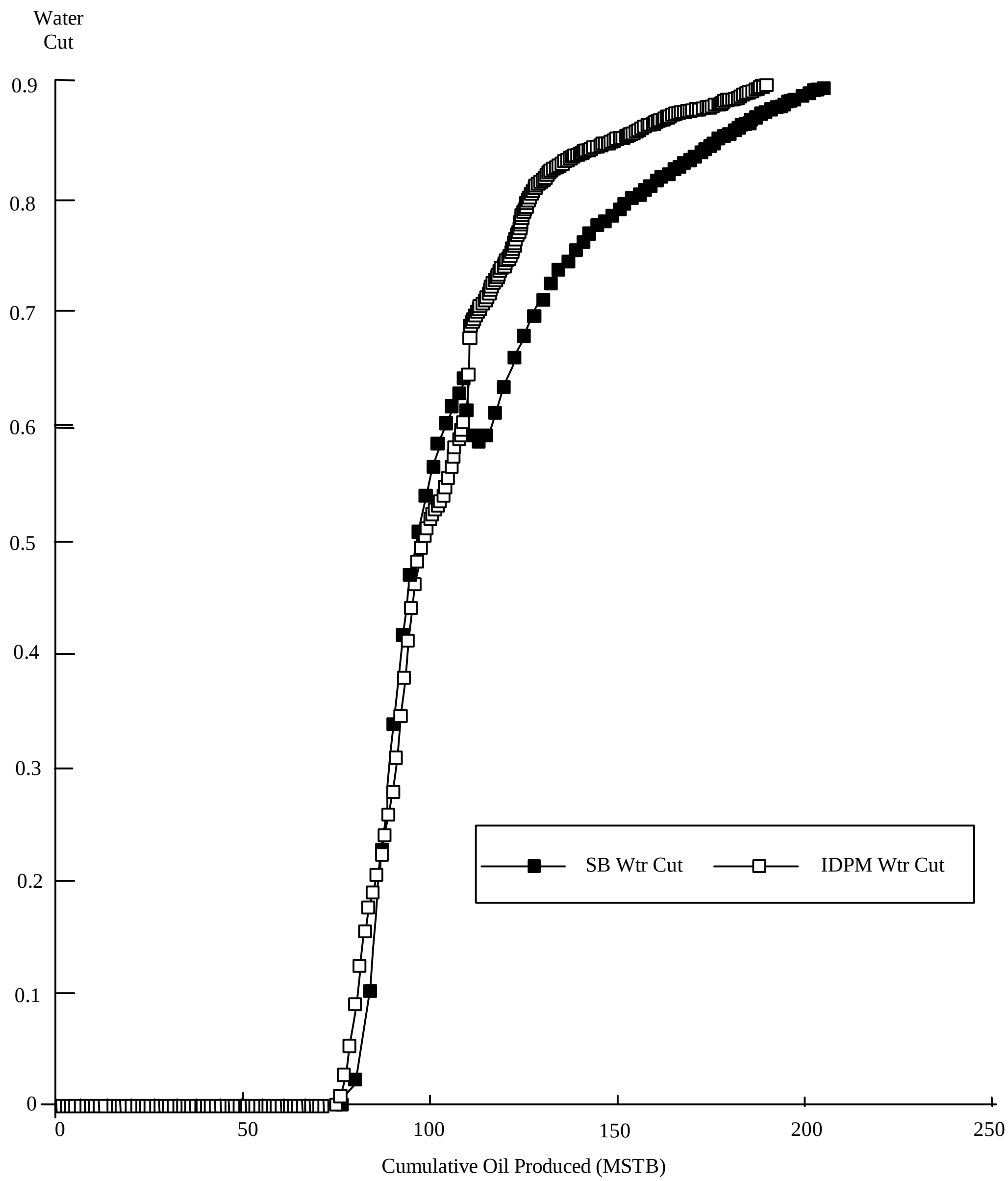
Figure 4.2 illustrates the comparison of IDPM and SimBest II water production over time. As was the case for oil production, the water rate curves match closely.

Figure 4.2
IDPM Verification Against Black Oil Simulation (SSI's SimBest II Water Rate 1/8 5-Spot



Finally, Figure 4.3 shows water cut versus cumulative oil production for both IDPM and SimBest II results. The IDPM - SimBest II comparison for this plot is quite good for the pre-infill time period. However, at the time of infill, IDPM water cut continues to increase whereas SimBest II water cut drops from .64 to .59.

Figure 4.3
IDPM Verification Against Black Oil Simulation (SSI's SimBest II)
Water Cut vs. Cumulative Oil Produced



One would expect a decrease in water cut at the time of infill as SimBest II calculates. The IDPM water cut results are related to the high initial connectivity value. In this particular case, the high connectivity value defines an entirely continuous reservoir. As a result, IDPM water saturation values at the infill location are higher than they would be for a less continuous reservoir, everything else being equal. Sections 5 and 6 of this manual describe IDPM runs with lower initial connectivity values (.55) in which water cut at infill drops, as expected.

SECTION 5
VALIDATION OF IDPM AGAINST FIELD FLOOD RESULTS

The IDPM validation runs were made using Exxon's field data for the Robertson Clearfork Unit. Appendix 2a contains a copy of the SPE paper, “Quantitative Analysis of Infill Performance: Robertson Clearfork Unit" (SPE 15568), from which input parameters and production data were obtained for validation purposes. The paper provides concise summaries of the geology, trapping mechanism, lithology, depositional environment, and development history for the Robertson Clearfork Unit. Values for average permeability, porosity, and net pay were obtained from SPE 11023, "Infill Drilling to Increase Reserves -Actual Experience in Nine Fields in Texas, Oklahoma, and Illinois. " A copy of this paper is also included in Appendix 2a.

Water flooding began in the Robertson Clearfork Unit in the early 1970's utilizing 80 acre 5-spot patterns. The unitized interval consists of the Glorieta, Upper Clearfork, and Lower Clearfork formations. By 1972, the flood included 33 water injectors. In 1976, Exxon began an infill drilling program which converted the original 5-spot patterns to 80 acre inverted 9-spot patterns. As seen in Figure 1 of SPE 15568 in Appendix 2a, a significant increase in oil production was the result of these first round of infills.

The IDPM was used to see if it would predict similar increases in oil and water production for 5-spot to 9-spot infilling. The parameters used in the validation run included the following:

Dykstra-Parsons coefficient, Vdp = .83
Plug Back each layer at water cut of .90
8 Layers
K = .65 md
Ky/Kx = 1
Kz/Kx = 0
5-spot (pre-infill) to 9-spot (infill)
80 acre non infill pattern area
Connectivity, C = .55 (at 1320 ft well spacing)
Non infill injection rate = 200 STBW/Day
Infill injection rate =450 STBW/Day
Water cut at infill, fw = .60
Water cut at economic limit, fwe = .90
Viscosity ratio, uo/uw = 2

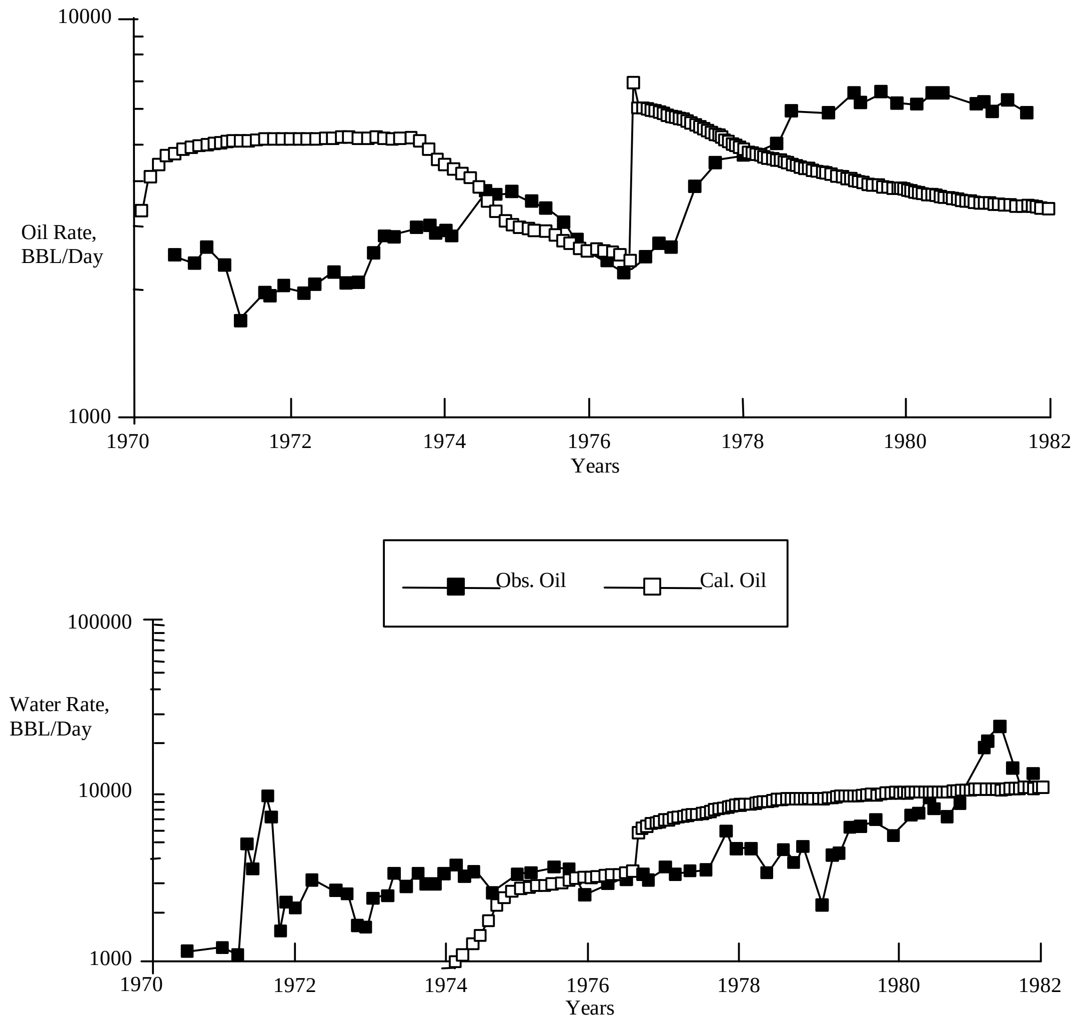
For a more detailed listing of all parameters see the Robertson Clearfork Unit IDPM input and output in Appendix 2b.

Eight layers were used in the IDPM to account for multiple pay stringers. Layers were plugged once water cut exceeded .60 for the layer. The connectivity value of .55 was obtained from Figure 1.10 in Section 1. Injection rates were calculated from withdrawals. For the 80 acre 5-spot water flooding, withdrawals were 3,900 RBOPD and 3,000 RBWPD or 6,900 RBPD. For 33 patterns, this is an average of 200 RBPD/pattern. After infilling, the 80 acre 9-spot patterns averaged withdrawals of 6,900 RBOPD and 8,000 RBWPD or 14,900 RBPD. This is an average of 450 RBPD/pattern.

Figure 5.1 illustrates the results obtained from the IDPM run compared to observed field data. IDPM output results are given for 1/8 of the original 5-spot pattern. In order to compare IDPM output with the observed field data, the IDPM output was multiplied by 8 to scale up to full pattern results and then multiplied by 33 to scale up to full field results.
IDPM results near the time of infill are quite good. The decline of oil production from 1974 to 1976 was matched, and the increase in oil production at infill was in line with the observed data.

In this sense, IDPM did a very adequate job in forecasting the initial increase in oil production due to infill.

Figure 5.1
IDPM Field Data Validation -- Robertson Clearfork Unit
Observed and IDPM Calculated Oil and Water Production



For the years 1971 through 1974, the IDPM results do not compare well with the observed data. IDPM calculated oil production was almost twice as much as observed oil production, and IDPM calculated water production was significantly lower than observed water production during this time period. In fact there was no appreciable calculated water production (more than 1,000 BWPD) until 1974.

The drastic difference between calculated and observed data during these years is related to primary production. The actual field data reflects production from initial water flood start-up after primary depletion of the reservoir. IDPM, version 1.2 does not account for this primary production. Instead, oil saturation is at initial conditions as defined by the input connate water saturation. As water was injected in the IDPM, oil immediately was produced as should be the case in an incompressible system. An upgrade to version 1.2 should be considered to properly account for primary production.

After infilling from 5-spot to 9-spot in 1976, IDPM calculated oil and water production increased instantaneously. Both observed oil and water production data lag behind the calculated data as expected since the infills were not all completed at once. The IDPM effectively matched the 9-spot oil production increase and sustained this increase for a year before assuming a decline which was similar to 5-spot water flood decline (1974-1976).

The IDPM calculated infill response at 1976 and beyond is typical of what happens with infill drilling. However, the observed data not only shows oil production doubling, but this rate is sustained for three years until more infill drilling takes place. The observed data here is showing an effect which is due to something beyond infilling from a 5-spot to 9-spot. There may be something field related or operations related that has allowed production to make such a drastic change in character. If this is not an operational phenomenon, perhaps Figure 1.10 does not represent accurately enough the connectivity characteristics of the Robertson Clearfork Unit reservoir. In other words, the improvement in connectivity upon infilling may have been greater than what was input into the IDPM model. New reservoirs may have been tapped with the infill drilling.

Despite the differences in calculated versus observed data in the early time 5-spot and the late time 9-spot data, the IDPM successfully validated the increase in production seen at the time of infill for the Robertson Clearfork Unit.

SECTION 6
IDPM SENSITIVITY ANALYSIS

The IDPM sensitivity runs were conducted using Unocal's field data for the North Riley Unit. The enclosed paper by Fuller, Sarem, and Gould, "Screening Waterfloods for Infill Drilling Opportunities," explains the area in more detail (Appendix 3a). Note that the sensitivity results described within the above mentioned paper vary slightly with those that follow. In the paper, the highest permeability layer was specified to be in the middle whereas the following sensitivity runs specify the highest permeability to be in the bottom layer.

The base case for the sensitivity runs uses the following critical parameters:

Dykstra-Parsons coefficient, Vdp = .83
No Plug Backs
11 Layers
Ky/Kx = 1
KZ/Kx =.1
5-spot (pre-infill) to 5-spot (infill)
40 acre non infill pattern area
Connectivity, C = .55 (at 933 ft well spacing)
Non infill injection rate =200 STBW/Day
Infill injection rate =400 STBW/Day
water cut at infill, fw = .75
water cut at economic limit, fwe = .95
Viscosity ratio, uo/uw =2.83
IDPM Default Economic Criteria
Oil Price = $20/STB

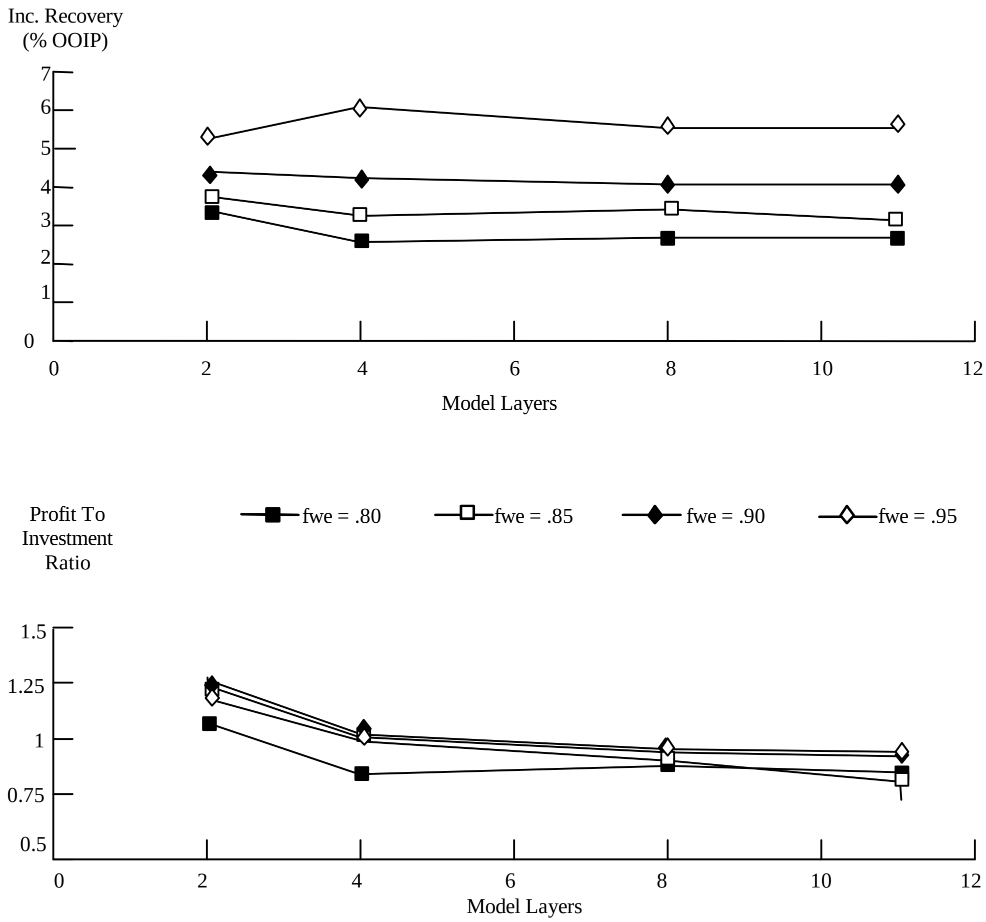
For a more detailed listing of all parameters see the North Riley Unit Base Case Listing in Appendix 3b.

Number of Model Layers

As Figure 6.1 illustrates, incremental oil recovery due to infill drilling generally is the same for all layers at a given economic limit water cut (fwe). The recovery tends to level out as the number of layers increase above 8. As expected, incremental oil recovery increases with increasing fwe regardless of layer number.

Figure 6.1 also shows the profit to investment ratio (P/I) sensitivity to the number of layers in the model. With fewer layers (less than 4), even though more oil is recovered as fwe increases, P/I may decrease. For example in a 2 layer system, P/I for a fwe of .95 is less than P/I for an fwe of .90. However, this is not the case for models with more than 4 layers.

Figure 6.1
Infill Drilling Predictive Model Sensitivity Runs - No. of Model Layers



Conditions:

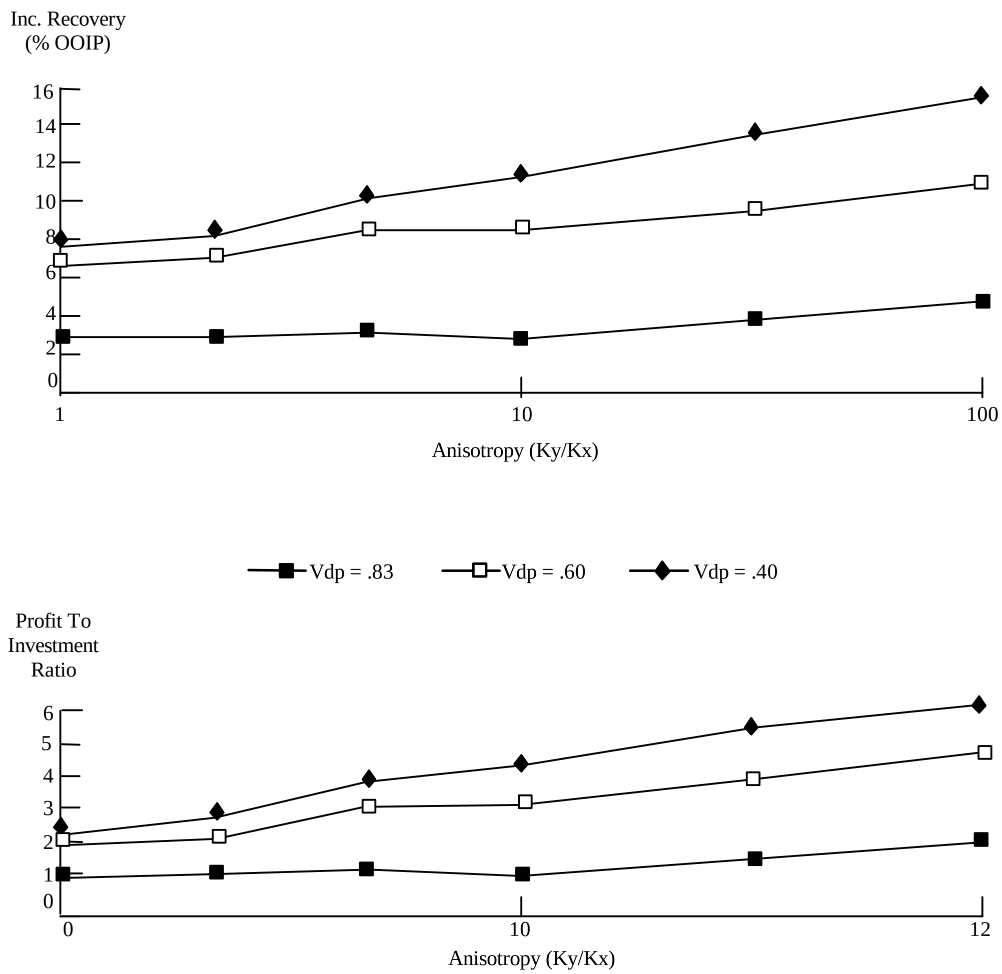
5-Spot to 5-Spot Infill	40 Acre Non Infill 5-spot Pattern
Vdp = 0.83	C = 0.55 (at 933' Well Spacing)
No Plug Backs	Non Infill Injection Rate = 200 STB/D
Ky/Kx = 1.0	Infill Injection Rate = 400 STB/D
Kz/Kx = 0.1	fwi = 0.75 uo/uw = 2.83
Oil Price = $20.00/STB	

Areal and Vertical Heterogeneity and Sweep

The effects of areal heterogeneity on areal sweep were simulated within the IDPM using anisotropy (Ky/Kx). The effects of vertical heterogeneity on vertical sweep were simulated using the Dykstra-Parsons coefficient for permeability variation (Vdp). With an average permeability of 10 md for all layers combined, Vdp is used to distribute varying permeabilities to each layer.

As Figure 6.2 indicates, the trends in both the incremental recovery and P/I plots are very similar. Recovery and P/I increase with increasing anisotropy (Ky/Kx) and decreasing vertical heterogeneity (Vdp). When there is significant vertical heterogeneity (high Vdp value), thief zones dominate and overshadow the effect of areal heterogeneity. With a Vdp of .83, oil recovery is about the same regardless of Ky/Kx values. With lower Vdp values, areal heterogeneity makes a larger difference in oil recovery and P/I, especially with Ky/Kx values greater than 10.

Figure 6.2
Infill Drilling Predictive Model -- Sensitivity Runs-Areal (Ky/Kx) & Vertical (Vdp) Sweep



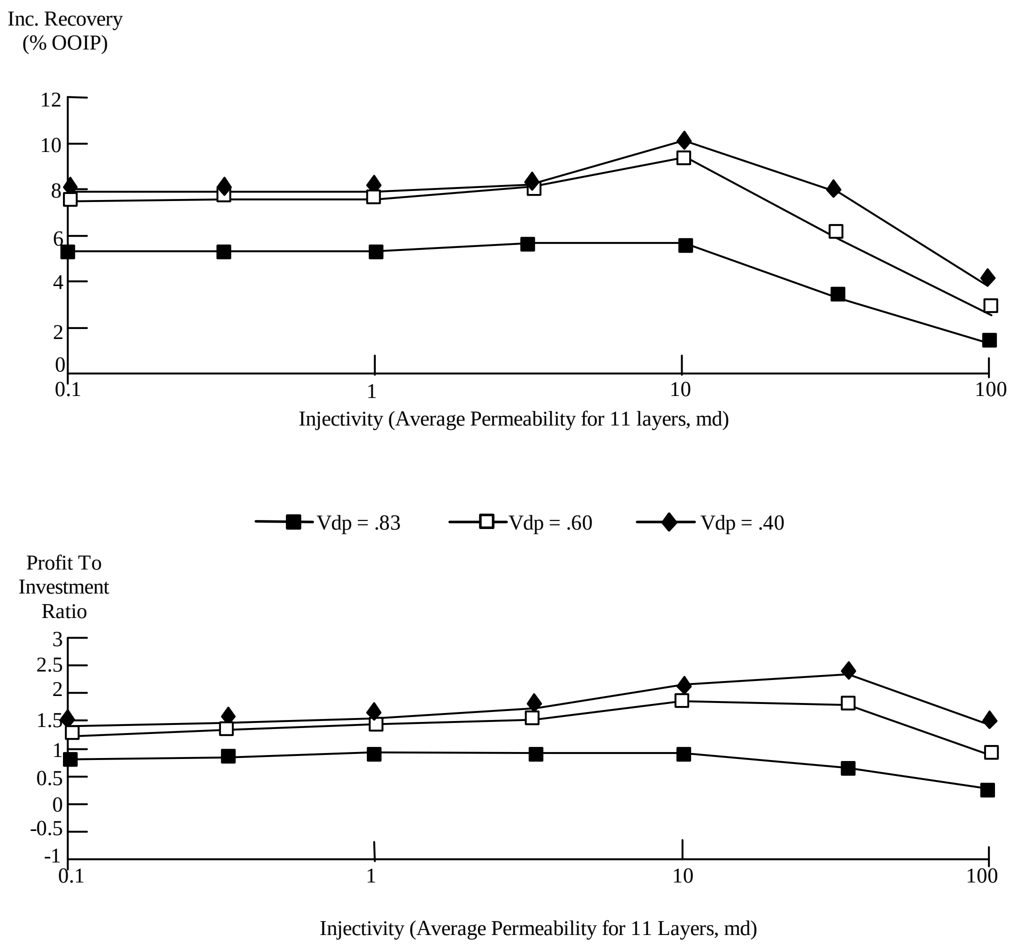
Conditions:

5-Spot to 5-Spot Infill	40 Acre Non Infill 5-spot Pattern
11 Layers	C = 0.55 (at 933' Well Spacing)
No Plug Backs	Non Infill Injection Rate = 200 STB/D
Kz/Kx = 0.1	Infill Injection Rate = 400 STB/D
Oil Price = $20.00/STB	fwi = 0.75 fwe = 0.83
	uo/uw = 2.83

Injectivity (Average Permeability) and Vertical Sweep (Vdp)

Injectivity was varied within the IDPM by varying the combined average permeability for the 11 layers in the model. As Figure 6.3 illustrates, for all Vdp values, there is a gradual increasing trend for oil recovery as average model permeability increases from .1 md to 10 md. Oil recovery peaks at this point and begins to decline rapidly with increasing permeability. For the given conditions in the model, improving average permeability above 10 md improves the non infill 5-spot performance to the point that it becomes less attractive to infill. This same general trend is seen in the P/I plot.

Figure 6.3
Infill Drilling Predictive Model -- Sensitivity Runs - Injectivity (Average Permeability)



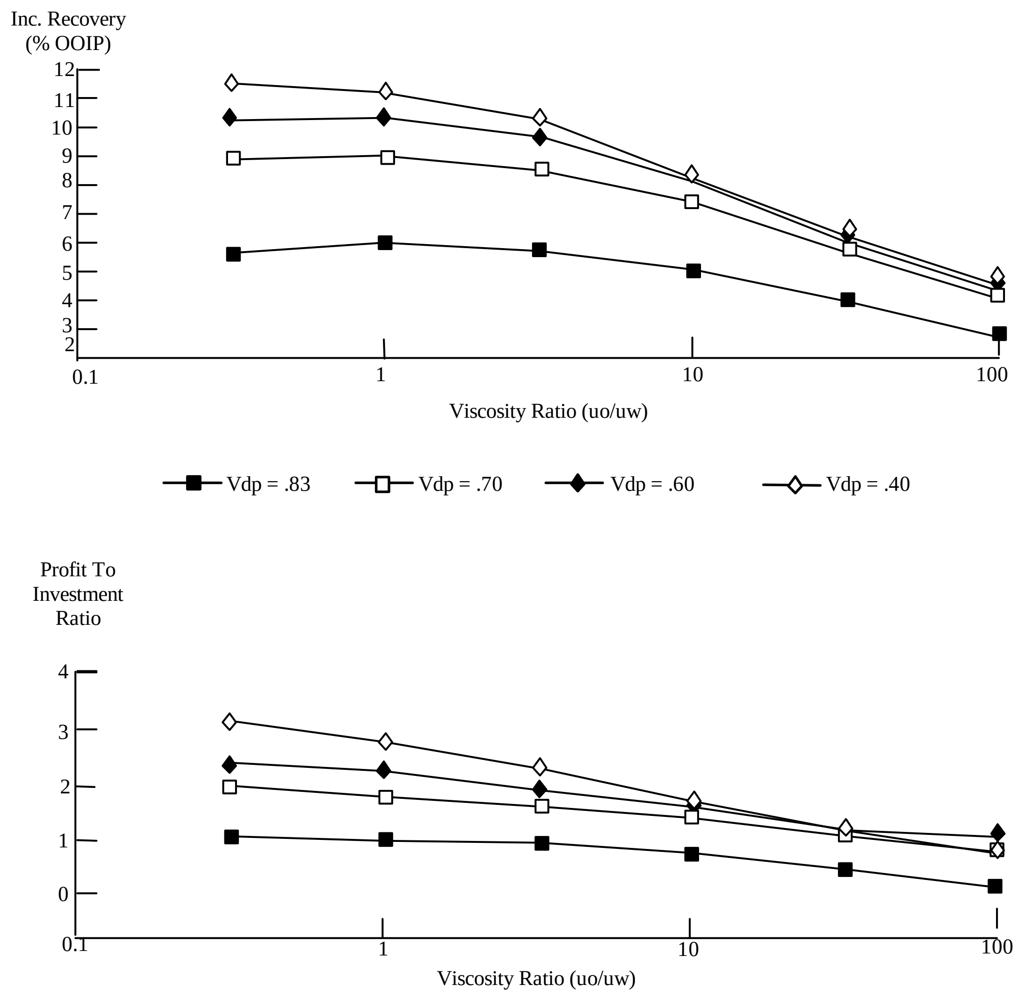
Conditions:
5-Spot to 5-Spot Infill
11 Layers
No Plug Backs
Kz/Kx = 1.0 Kz/Kx = 0.1
Oil Price = $20.00/STB

40 Acre Non Infill 5-Spot Pattern
C = 0.55 (at 933' Well Spacing)
Non Infill Injection Rate = 200 STB/D
Infill Injection Rate = 400 STB/D
fwi = 0.75 fwe = 0.95
uo/uw = 2.83

Viscosity Ratio (uo/uw) and Vertical Sweep (Vdp)

Figure 6.4 illustrates that the largest oil recovery and P/I occur with favorable viscosity ratios (uo/uw = 1) and low permeability variations (Vdp =.4). As expected, oil recovery and P/I decrease as viscosity ratio increases and Vdp increases. The only exception to this trend is in the P/I plot for a Vdp of .4 at viscosity ratios of 30 or more. The calculated oil recovery and P/I for high viscosity ratios (greater than 10) are not as accurate as those calculated for lesser viscosity ratios. The streamtubes within IDPM are static. With static streamtubes, it is difficult to model the viscous fingering effects which take place with high viscosity ratios. Therefore, there is some calculation error in the high viscosity ratio range. However, IDPM can still be used as an effective screening tool for these high viscosity ranges.

Figure 6.4
Infill Drilling Predictive Model -- Sensitivity Runs - Viscosity Ratio (uo/uw) & Vertical Sweep (Vdp)



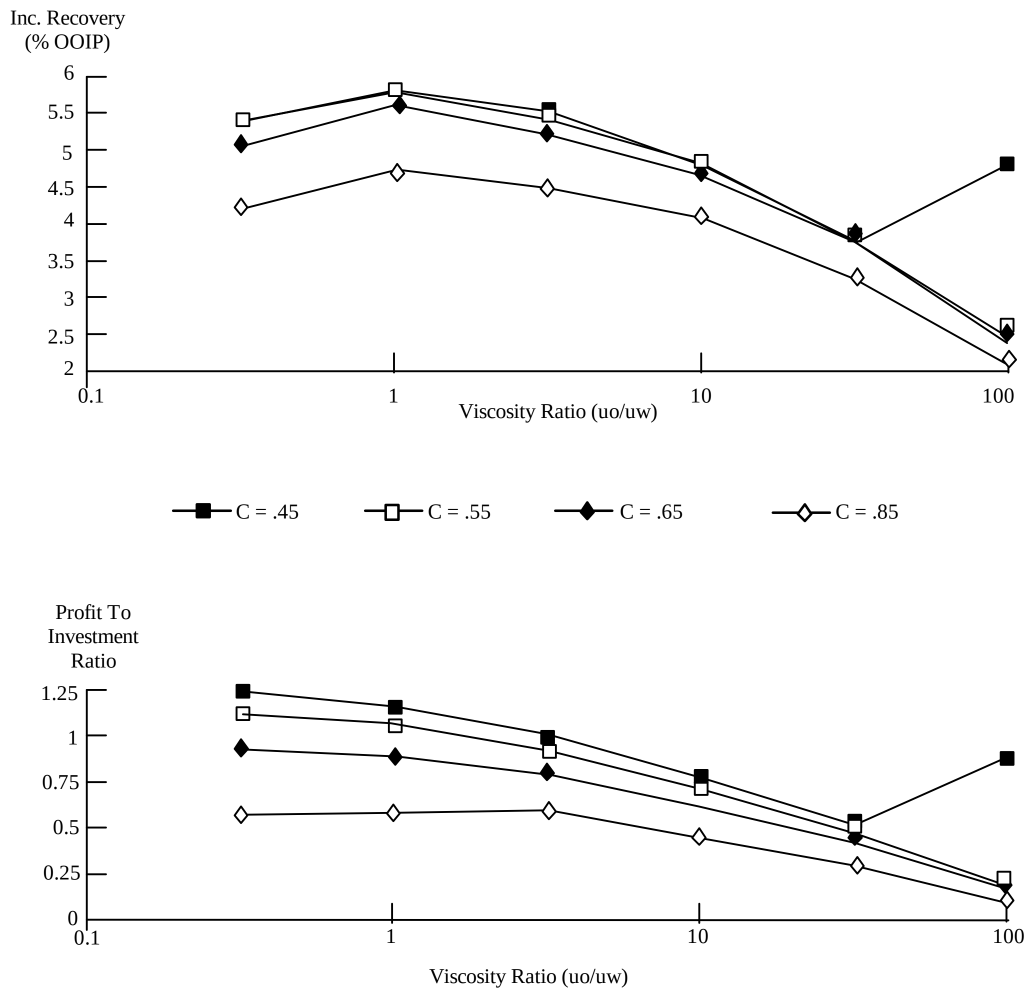
Conditions:

5-Spot to 5-Spot Infill	40 Acre Non Infill 5-Spot Pattern
11 Layers	C = 0.55 (at 933' Well Spacing)
No Plug Backs	Non Infill Injection Rate = 200 STB/D
Kz/Kx = 1.0	Infill Injection Rate = 400 STB/D
Kz/Kx = 0.1	fwi = 0.75 fwe = 0.95
Oil Price = $20.00/STB	

Viscosity Ratio (uo/uw) and Continuity (C)

In Figure 6.5, for favorable viscosity ratios near 1, incremental oil recovery and P/I due to infilling increase with decreasing continuity or connectivity between wells. However, as continuity decreases below .55 for the given conditions, the increase in incremental oil and P/I becomes negligible. For example, there is very little difference in the recovery and P/I for continuity values of .55 and .45. The erroneously high recovery and P/I value for continuity equal to .45 and viscosity ratio equal to 100 demonstrates the limits of the IDPM's static stream tubes for high viscosity ratio ranges.

Figure 6.5
Infill Drilling Predictive Model - Sensitivity Runs
Viscosity Ratio (uo/uw) & Continuity (C)



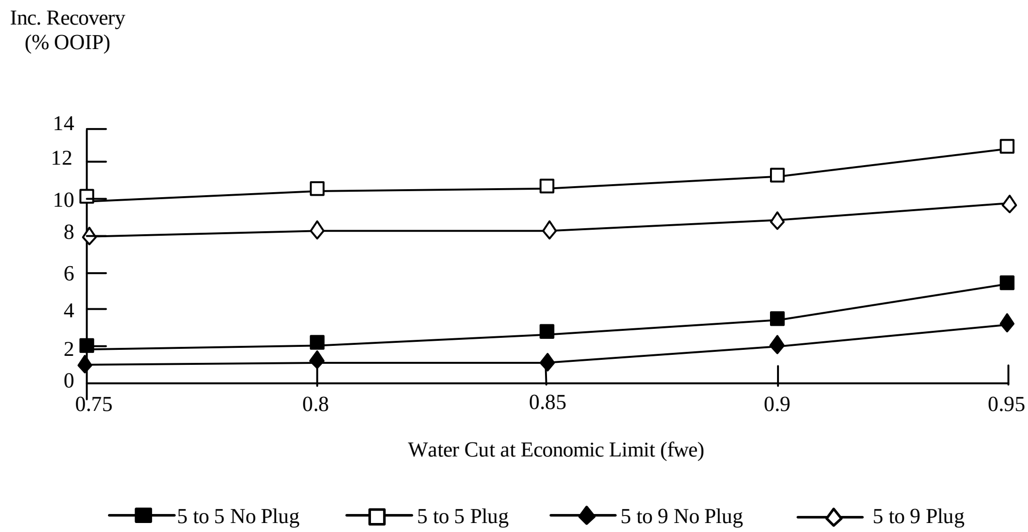
Conditions:

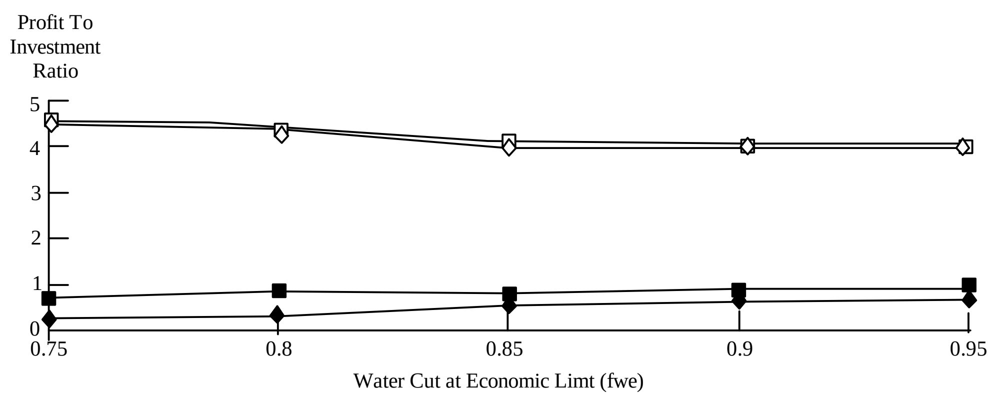
5-Spot to 5-Spot Infill	40 Acre Non Infill 5-Spot Pattern
Vdp = 0.83	Non Infill Injection Rate = 200 STB/D
11 Layers	Infill Injection Rate = 400 STB/D
No Plug Backs	fwi = 0.75 fwe = 0.95
Kz/Kx = 1.0 Kz/Kx = 0.1	
Oil Price = $20.00/STB	

Infill Pattern Type and Plug Back

IDPM was used to analyze the effect of infilling a 40 acre 5-spot and converting it to a 40 acre 9-spot versus infilling to convert to a 20 acre 5-spot. The results in Figure 6.6 show that both incremental oil recovery and P/I are higher with a 5-spot to 5-spot conversion at all economic limit water cuts (fwe). The effect of plug back is also shown in this figure. In fact, plugging back watered out zones has a greater incremental effect on increasing oil recovery and P/I than does infill pattern type.

Figure 6.6
Infill Drilling Predictive Model - Sensitivity Runs - Infill Pattern Type and Plug Back





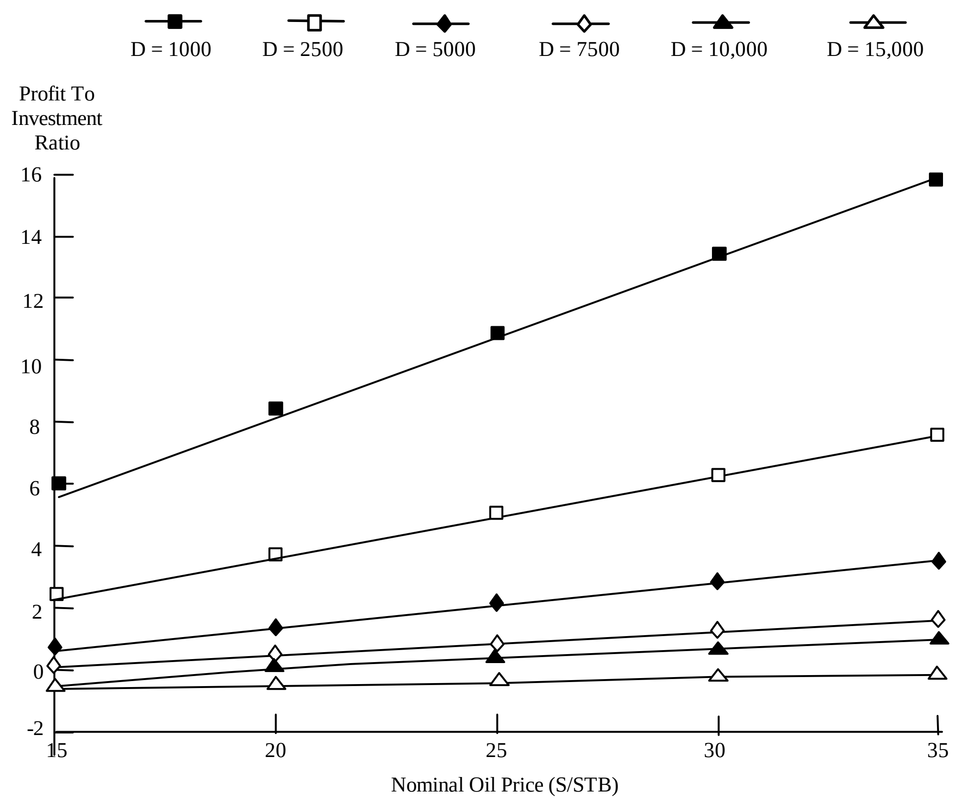
Conditions:

Vdp = 0.83	40 Acre Non Infill 5-Spot Pattern
11 Layers	C = 0.55 (at 933' Well Spacing)
Kz/Kx = 1.0	Non Infill Injection Rate = 200 STB/D
Kz/Kx = 0.1	Infill Injection Rate = 400 STB/D
Oil Price = $20.00/STB	fwi = 0.75 uo/uw = 2.83

Oil Price and Depth

Figure 6.7 displays IDPM's sensitivity to oil price and depth. As expected, P/I improves with increasing oil price and decreasing depth.

Figure 6.7
Infill Drilling Predictive Model - Sensitivity Runs - Oil Price and Depth



Conditions:

5-Spot to 5-Spot Infill	40 Acre Non Infill 5-Spot Pattern
Vdp = 0.83	C = 0.55 (at 933' Well Spacing)
11 Layers	Non Infill Injection = 200 STB/D
No Plug Backs	Infill Injection = 400 STB/D
Kz/Kx = 1.0	fwi = 0.75 fwe = 0.95
Kz/Kx = 0.1	uo/uw = 2.83

SECTION 7
IDPM SUBROUTINE GLOSSARY

ECONOMICS COMMONS--ECON

COMMON /ECS/

SUMVOM	-	Total Oil Produced, MBBL
CIOR	-	Not used
TOTD	-	Total tangible capital, present value (discounted), MM$
SUMCI	-	Total intangible capital, present value (discounted), MM$
SVOS	-	Total gross oil sold, MBBL (discounted)
SVGS	-	Total gross gas sold, MMSCF (discounted)
SVIS	-	Not used
SVPS	-	Not used
SUMWT	-	Total produced water treating cost, present value (discounted), MM$
SINT	-	Total interest cost, present value (discounted), MM$
SPRP	-	Total principal repayment, present value (discounted), MM$
SUMOH	-	Total overhead cost, present value (discounted), MM$
USOH	-	Total overhead cost (undiscounted), MM$
DCE	-	Not used
CINJ	-	Cost of drilling and completion for in injection well ($/well)
CEQP	-	Cost to equip new producing well ($/new producer)
CSEC	-	Cost of additional secondary production equipment for a primary well converted to a secondary, $/well
CNVT	-	Cost to convert an existing producer to an injection well, $/converted well
CREP	-	Cost to upgrade surface processing equipment and lease facilities for secondary recovery operations, $/producing well
CDAO	-	Direct annual operating costs for secondary recovery operations, $/producing well/yr
CIWO	-	Additional annual operating costs for offshore water injection, $/yr
URPV	-	Total gross revenue (undiscounted), MM$
UNOS	-	Total net oil sales (undiscounted), MM$
USEV	-	Total severance tax (undiscounted), MM$
USFO	-	Total fixed operating cost (undiscounted), MM$
USOPC	-	Total variable operating cost (undiscounted), MM$
USTR	-	Not used
USWO	-	Total well workover cost (undiscounted), MM$
USTO	-	Total operating cost, variable + fixed (undiscounted), MM$
USIN	-	Not used
USWT	-	Total produced water treating cost (undiscounted), MM$
UWCAP	-	Total working capital (undiscounted), MM$
USTC	-	Total tangible capital (undiscounted), MM$
USCI	-	Total intangible capital (undiscounted), MM$
USTI	-	Total technician and instrument cost (undiscounted), MM$
UCFB	-	Total cash flow before tax (undiscounted), MM$
UWPT	-	Total windfall profits tax (undiscounted), MM$
USIT	-	Total state income tax (undiscounted), MM$
UFIT	-	Total federal income tax (undiscounted), MM$
UATP	-	Total after tax profit (undiscounted), MM$
UINT	-	Total interest cost (undiscounted), MM$
ULOAN	-	Total principal repayment (undiscounted), MM$
SRPV	-	Total revenue, present value (discounted), MM$
SNOS	-	Total net oil sales, present value (discounted), MM$

SSEV	-	Total severance tax, present value (discounted), MM$
SUMFO	-	Total fixed operating cost, present value (discounted), MM$
SUMOPC	-	Total variable operating cost, present value (discounted), MM$
SUMTR	-	Not used
SUMWO	-	Total well workover cost, present value (discounted), MM$
DCFB	-	Total discounted cash flow before tax, MM$
MUPPV	-	Mean discounted cash flow, MM$
STDDEV	-	Standard deviation of the mean discounted cash flow, MM$
PAYOUT	-	Time at which after tax discounted cash flow = 0, years
PLIFE	-	Project economic life, years
ROR	-	Mean DCF rate of return, percent
CC	-	Present value rate=(1.+XINF)*(1.*XDR)-1.
SUMIN	-	Total injection cost, MM$ (not used)
SUMWC	-	Total working capital, present value (discounted), MM$
DNB	-	Present value of net oil sold (discounted), MBBL
SVON	-	Cumulative net oil sold, MBBL
EFFINV	-	Mean investment efficient = ratio of sum of positive discounted cash flows to absolute value of sum of negative discounted cash flows

COMMON /ECC/

MUVO(50)	-	Mean oil volume, BBL
MUVG(50)	-	Mean gas volume, MMSCF
MUVW(50)	-	Mean water volume, BBL
MUVI(50)	-	Not used
MUPO(50)	-	Mean oil price, MM$/BBL
MUPG(50)	-	Mean gas price, MM$/MSCF
MUPI(50)	-	Not used
MUPP(50)	-	Not used
MUWO(50)	-	Mean well workover cost, MM$
MUFO(50)	-	Mean fixed operating cost, MM$/yr
MUOPC(50)	-	Mean variable operating cost, MM$/BBL oil prod
MUTR(50)	-	Not used
MUCT(50)	-	Mean tangible capital, MM$
MUCI(50)	-	Mean intangible capital, MM$
MUDB(50)	-	Mean debt added, MM$
MUPP(50)	-	Mean principal repayment, MM$
MUIN(50)	-	Mean interest payment, MM$
MUPB(50)	-	Mean principal balance at end of year (after principal payment), MM$
SIGVO(50)	-	Oil volume variance, STB/yr
SIGPO(50)	-	Oil price variance, MM$/BBL
SIGPG(50)	-	Gas price variance, MM$/MSCF
SIGPI(50)	-	Not used
SIGFO(50)	-	Fixed operating cost variance, MM$/yr
SIGTR(50)	-	Not used
SITRT(50)	-	Tangible capital variance, MM$/yr
SITRI(50)	-	Intangible capital variance, MM$/yr
SIGOPC(50)	-	Variable operating cost variance, MM$/BBL oil produced
SIGPP(50)	-	Not used

COMMON /ECI/

M	-	Number of years in the project (for all patterns)
MYR	-	Number of years of production
IOUT	-	Print control for economic calculations
ISTATE	-	State code
IDIST	-	District code (within a state)
IFIT	-	Federal income tax credit option
IDISC	-	Control for discounting method
IDEP	-	Control for depreciation method
IPLIF	-	Control on economic life
ISO	-	Control for reading secondary oil volumes
CCHM	-	Not used
CSCAP	-	Not used
CWAT	-	Capital for water injection plant, M$
CWCAP	-	Capacity of water injection plant, MMBBL/YR
WPHO	-	Windfall tax beginning phase out date
EPHO	-	Windfall tax ending phase out date
BTIM	-	Base time for project start
BPOW	-	Base oil price at start of project for purposes of WPT calculations, $/BBL
PIPEL	-	Not used
PCAP	-	Not used
PDPM	-	Not used
PFOC	-	Not used
CPIPL	-	Not used
DTIM	-	Investment depreciation time, yrs
WCAP	-	Months of working capital, months
UNCO	-	Oil rate uncertainty, fraction
COSTRT	-	Project startup costs, M$
XDR	-	Monetary discount rate, fraction
XINF	-	Inflation rate, fraction
XROY	-	Royalty rate, fraction
XSEV	-	Severance tax rate, fraction
XWPT	-	Windfall excise tax rate, fraction
XFIT	-	Federal income tax rate, fraction
XTCR	-	Investment tax credit, fraction
XSTX	-	State income tax rate, fraction
WOCOST	-	Annual well workover cost per pattern, MS
PCTDBT	-	Percent of capital (tangible and intangible) costs to be borrowed, percent
DBTINT	-	Debt interest rate, percent
NYRRPY	-	Number of years before beginning debt repayment
NYPAID	-	Number of years before completing debt repayment
DEBT	-	Control on debt calculations
WTCOST	-	Produced water treating cost, $/BBL
ESCPO	-	Escalation rate of oil price, fraction
ESCPG	-	Escalation rate of gas price, fraction
ESCPI	-	Not used
ESCFO	-	Escalation rate of fixed operating costs, fraction
ESCTR	-	Not used
ESCCT	-	Not used
ESCCI	-	Not used
ESCWO	-	Escalation rate of well workover costs, fraction
ESCWT	-	Escalation rate of tangible capital, fraction
ESCWI	-	Escalation rate of intangible capital, fraction
ESCBP	-	Inflation rate plus two percent
FOCPL	-	Fixed operating cost per pattern, low, $/yr

FOCPM	-	Fixed operating cost per pattern, most likely, $/yr
FOCPH	-	Fixed operating cost per pattern, High, $/yr
WPP1	-	Number of injectors drilled per pattern
WPP2	-	Number of producers drilled per pattern
WPP3	-	Number of primary producers converted to secondary producers per pattern
WPP4	-	Number of existing producers converted to injectors per pattern
OILB	-	1979 project base oil rate, MBBL/TR
OILC	-	Current NON-tertiary project oil rate, MBBL/YR
DECL	-	Annual oil production decline rate, fraction
OILR(50)	-	Oil released, BBL
VOS(50)	-	Volume of secondary oil produced per pattern, MBBL/YR
POL(50)	-	Oil price, low, $/BBL
POM(50)	-	Oil price, most likely, $/BBL
POH(50)	-	Oil price, High, $/BBL
PIL(50)	-	Not used
PIM(50)	-	Not used
PIH(50)	-	Not used
PPL(50)	-	Not used
PPM(50)	-	Not used
PPH(50)	-	Not used
FOCL(50)	-	Fixed operating cost per pattern, low, $/yr
FOCM(50)	-	Fixed operating cost per pattern, most likely, $/yr
FOCH(50)	-	Fixed operating cost per pattern, high, $/yr
OPCL(50)	-	Variable operating cost, low, $/BBL oil produced
OPCM(50)	-	Variable operating cost, most likely, $/BBL oil produced
OPCH(50)	-	Variable operating cost, high, $/BBL oil produced
TRPL(50)	-	Not used
TRPM(50)	-	Not used
TRPH(50)	-	Not used
PGL(50)	-	Gas price, low, $/MSCF
PGM(50)	-	Gas price, most likely, $/MSCF
PGH(50)	-	Gas price, high, $/MSCF
CTPL(50)	-	Tangible capital costs per pattern, low,
CTPM(50)	-	Tangible capital costs per pattern, most likely, $
CTPH(50)	-	Tangible capital costs per pattern, high, $
CIPL(50)	-	Intangible capital costs per pattern, Low, $
CIPM(50)	-	Intangible capital costs per pattern, most likely, $
CIPH(50)	-	Intangible capital costs per pattern, high, $
CTCL(50)	-	Tangible capital costs for project, low, $
CTCM(50)	-	Tangible capital costs for project, most likely, $
CTCH(50)	-	Tangible capital costs for project, high, $
CICL(50)	-	Intangible capital costs for project, low, $
CICM(50)	-	Intangible capital costs for project, most likely, $
CICH(50)	-	Intangible capital costs for project, high, $
VOL(50)	-	Oil production for project, low, STB/yr
VOM(50)	-	Oil production for project, most likely, STB/yr
VOH(50)	-	Oil production for project, high, STB/yr
WO(50)	-	Well workover cost per pattern, $/yr
BPO(50)	-	Base price of oil for WPT, $/BBL
WTC(50)	-	Produced water treating cost for project, $/BBL
VGM(50)	-	Gas produced for project, most likely, MMSCF/yr
VWM(50)	-	Water produced for project, most likely, STB/yr
VIM(50)	-	Not used
VPM(50)	-	Not used
VPB(50)	-	Water injected for project, most likely, MBBL
TITL(20)	-	Up to 80 alpha-numeric characters to identify run

VOP(50)	-	Volume oil produced, MBBL/yr/pattern
VGP(50)	-	Volume gas produced, MMSCF/yr/pattern
VWCT(50)	-	Year-end water cut, fraction, /yr/pattern
VWP(50)	-	Volume water produced, MBBL/yr/pattern
VIP(50)	-	Not used
VPP(50)	-	Not used
VPBP(50)	-	Volume of water injected, MBBL/yr/pattern
PATI(50)	-	Number of patterns initiated each year of the project

COMMON /ECO/

DATE(50)	-	Date, year
VOSLD(50)	-	Annual volume of oil sold, MBBL
VONET(50)	-	Annual net oil sold (less royalty), MBBL
AFUEL(50)	-	Not used
VGNET(50)	-	Annual net gas sold (less royalty), MMSCF
AREVO(50)	-	Annual gross oil revenue, MM$
AREVG(50)	-	Annual gross gas revenue, MM$
ARVWPT(50)	-	Annual released oil revenue, MM$
AREV(50)	-	Annual gross revenue, MM$
AOVH(50)	-	Annual overhead, MM$
AOVH1	-	Annual overhead on drilling and completion, MM$
AROY(50)	-	Annual royalty, MM$
ANET(50)	-	Annual net revenue (less royalty), MM$
ASEV(50)	-	Annual severance tax, MM$
AWTC(50)	-	Annual produced water treating cost, MM$
AINJ(50)	-	Not used
AFOC(50)	-	Annual fixed operating cost, MM$
AVOC(50)	-	Annual variable operating cost, MM$
ATRC(50)	-	Not used
ACOST(50)	-	Annual total operating cost, MM$
ACAP(5O)	-	Annual intangibles and depreciation, MM$
AWPP(50)	-	Annual windfall price difference, $/BBL
TXCR(50)	-	Annual investment tax credit, MM$
DEPS(50)	-	Annual depreciation, MM$
AWCP(50)	-	Annual working capital, MM$
AQOR(50)	-	Oil production rate, BBL/D
AQGR(50)	-	Gas production rate, MSCF/D
AQWR(50)	-	Water production rate, BBL/D
AQIR(50)	-	Not used
ANOI(50)	-	Annual net operating income before WPT and FIT, MM$
AWPT(50)	-	Annual windfall profit tax MM$
ASTX(50)	-	Annual state income tax, MM$
ANTI(50)	-	Annual net taxable income, MM$
AFIT(50)	-	Annual federal income tax, MM$
ATPR(50)	-	Annual after tax cash flow, MM$
CFBT(50)	-	Cumulative cash flow before tax, MM$
CDBT(50Y	-	Cumulative cash flow before tax with constant dollars, MM$
DCFBT(50)	-	Cumulative discounted cash flow before tax, MM$
CNOI(50)	-	Cumulative net operating income, MM$
CFAT(50)	-	Cumulative cash flow after tax, MM$
CDAT(50)	-	Cumulative cash flow after tax with constant dollars, MM$
DCFAT(50)	-	Cumulative discounted cash flow after tax, MM$
PVDF(50)	-	Present value factor- 1.1(1.+CC)**(I-1)

COMMON /OUT/

CUMOS(5000)	-	Cumulative oil produced per pattern, MSTB
CUMGS(5000)	-	Cumulative gas produced per pattern, MMSCF
CUMWS(5000)	-	Cumulative water produced per pattern, MSTB
CUMIB(5000)	-	Cumulative water injected per pattern, MSTB
TIMS(5000)	-	Time, years
EWCUT(5000)	-	Interpolation array for calculation of VWCT (year-end water cut)

COMMON /LIFE/

IOPTS	-	Waterflood/infill drilling/incremental infill drilling control
IWLIFE	-	End of waterflood, year

COMMON /LIF/

LPAT	-	Estimated individual pattern life, years

SECTION 8
IDPM COMMON GLOSSARY

PARAMETERS

IYRMAX - Maximum number of years for economic calculations. All the time dependent variables in the economic package are dimensioned to this value.

IGDMAX - X-dimensions of the uniform grid (IGDMAX by JGDMAX) used to calculate stream flow rates for streamtube calculations, and to identify the locations of saturations and pressures from the non-infill case for interpolation of these values to the new infill streamtubes.

JGDMAX - Y-dimensions of the uniform grid (IGDMAX by JGDMAX). See IGDMAX above.

LGDMAX - The number of locations at which saturations and pressures are located for interpolation at infill time.

ISTMAX - Maximum number of timesteps for the reservoir model. The reservoir model bases timestep size on the throughput through the tube/layer that has the higher ratio of injection to pore volume, but the actual number of timesteps is controlled by the ending water cut value "CUTMAX" input by the user.

NTBMAX - Maximum number of stream tubes per layer. The most tubes used will be for the case of infill into a pattern for non-isotropic cases. NTBMAX must always be divisible by 4.

NXMAX - Maximum number of cells per streamtube for the reservoir calculations. The trade-off in this value is the spatial truncation error versus the run time and memory requirements.

ICRMAX - Dimension of unlabeled common in the reservoir calculations. During the reservoir calculations the saturations, flow coefficients, PVT properties, rel-perm values, pore volumes, and pressure equation coefficients are mapped into unlabeled common "A". Prior to the start of a run the size of ICRMAX is checked to determine if it is large enough for the problem.

LAYMAX - Maximum number of layers allowed for the current program dimensions.

COMMON /INSAV/

VP1B - Pressure values for all cells, tubes, and layers at the infill point from the non-infill case

VS01B - Oil saturation values at the infill time from the non-infill case

VSW1B - Water saturation values at the infill time from the non-infill case

COMMON /VCNTRL/

MLAYER - At any point and time in the reservoir calculations, this is the layer being processed

MTUBE - At any point and time in the reservoir calculations, this is the streamtube being processed

IGOIN - Plug-back control input variable

VCUT - Water cut when the infill case is to start

SGGV - Gas gravity, used in defaults for oil properties

IGOV - At any point in reservoir calculations, this is the case being run (2=non-infill, 1=infill

VAREA - Total pattern size in acres

VCONEC - Reservoir connectivity at VAREA pattern size

VCCN - Modified version of VCONEC used in subroutine WATSAT, computed once for efficiency
RSCALE - Scaling factor for going from element of symmetry in reservoir calculations to full pattern economics

COMMON /VINPUT/

VNX - Number of cells per tube
VCROC - Input pore volume compressibility
VREFP - Reference pressure, phi is at this pressure
VYEAR - Starting date of non-infill case
VPHI - Porosity by layer
VKX - X-direction permeability by layer
VKY - Y-direction permeability by layer
VH1 - Net pay by layer, Gross = Net
VZT - Elevation subsurface at top of each layer (negative)
VZB - Elevation at bottom of each layer
VP1 - Pressure in each cell, tube, and layer at time > 0
VSO - Oil saturation in each cell at time > 0
VSW - Water saturation in each cell at time > 0
VKZKH - Vertical permeability to X direction per ratio
VRATE1 - User-specified injection rate for entire pattern during infill
VRATE - User-specified injection rate for entire pattern during non-infill run
VANIS - Anisotropic value, KY/KX
ILAYER - Total number of layers in model
VTEMP - Reservoir temperature used in defaulting data

COMMON /WELLV/

VAOX Production well pressure coefficient
VRHSX - Production well right hand side term for use in generating coefficients
VPO - Oil production rate calculated for pressure specified well
VPW - Water production rate calculated for pressure specified well
VPI Well productivity index, calculated internally
VQW - Water injection rate for each tube
VPWELL - Bottomhole flowing pressure for production well

COMMON /WELLV1/

VPWEL1 - Bottomhole pressure for pressure specified injection wells in infill case
VPW1 - Calculated injection rate for pressure specified injection well
VAOX 1 - Pressure coefficient term for pressure specified injection well
VRHSX1 - Right hand side term for pressure specified injector

COMMON /LOCGET/

IPROD - Plug back indicator for each streamtube producer
IINJ - Plug back indicator for each streamtube injector

COMMON /VMODEL/

VP	-	Pressure in each cell at time 0
VSO1	-	Oil saturations at time zero
VSW1	-	Water saturations at time zero
VTX	-	Transmissibility between cells in a streamtube
VTY	-	Not used
VZAVG	-	Cell mid-point elevations
VTZ	-	Transmissibility between layers
VPV1	-	Pore volumes at REFP for each cell in model

COMMON /VSAVE/

NGCELT	-	Reservoir tube that each streamtube grid cell is located in for the non-infill case
NGCELC	-	Reservoir grid cell that each streamtube grid cell is located in for the non-infill case
IGCELT	-	Reservoir tube that each streamtube grid cell is located in for the infill case
IGCELC	-	Reservoir grid cell that each streamtube grid cell is located in for the infill case

COMMON /CELL/

NUMTUB	-	Maximum (input) number of streamtubes in model per layer
NOTUBS	-	Actual number of streamtubes in model per layer
ATOT	-	Total volume of each streamtube
ATOTAL	-	Total volume of all cells in layer
RX	-	X-direction location of center of mass of grid cell
RY	-	Y-direction location of center of mass of grid cell
RWIDE	-	Width of each grid cell
RLENG	-	Length of each grid cell
AVOL	-	Relative volume of each grid cell
KMRKSL	-	Counter for arbitrating hits in subroutine MARKSL

COMMON /AV/

VXNO	-	Oil relative permeability curve shape factor
VXNW	-	Water relative permeability curve shape factor
VXKROE	-	Oil relative permeability at VSWC for VCONEC =1.0
VXKRWE	-	Water relative permeability at VSORW for VCONEC =1.0
VSWC	-	Water connate saturation
VSORW	-	Residual oil saturation to a waterflood

COMMON /RATEV/

OILRAT	-	Non-infill oil rate at each timestep
WATRAT	-	Non-infill water rate at each timestep
TTIME	-	Cumulative time at each timestep for non-infill
OILRT1	-	Infill oil rate at each timestep
WATRT1	-	Infill water rate at each timestep
TTIM1	-	Cumulative time at each timestep for infill
OILCM	-	Cumulative oil at each timestep for non-infill
PVIN	-	Pore volumes injected at each timestep for non-infill
OILRC	-	Oil recovery at each timestep in non-infill
WCT	-	Water cut at each timestep in non-infill
OILCM1	-	Cumulative oil at each timestep for infill

PVIN1	-	Pore volumes injected at each timestep for infill
OILRC1	-	Oil recovery at each timestep in infill
WCT1	-	Water cut at each timestep in infill

COMMON /CONT1/

IARRP	-	Array output control
IANALP	-	Reservoir calculations analysis output control
ISTRMP	-	Streamtube output control
IECONR	-	Economic calculations control
DYKST	-	Dykstra-Parsons VDP value
IDYST	-	Layer Dykstra-Parsons calculation method selector
ITITV	-	Reservoir calculations title

COMMON /BLANK/

A	-	Work space for reservoir calculations
ACORE	-	Total size of work space

COMMON /AUTO/

CUTMAX	-	Water cut at end of run for both non-infill and infill cases
DTMAX	-	Unused
DTLAST	-	Unused
DTPER	-	Unused
DSMAX	-	Unused
DSGIVN	-	Unused
DELTAT	-	Timestep size (constant)
CUMTIM	-	Cumulative time in reservoir calculations
STOPIT	-	Switch used to signal end to simulator run

COMMON /OIP/

OIP	-	Oil in place
WIP	-	Water in place
GIP	-	Unused
OIPOLD	-	Oil in place last timestep
WIPOLD	-	Water in place last timestep
GIPOLD	-	Unused
OIPOR	-	Original oil in place
WIPOR	-	Original water in place
ORIGPV	-	Original pore volume
PVTOT	-	Total pore volume
HCPORV	-	Hydrocarbon pore volume

COMMON /SIZE/

NCORE	-	Size of blank common
IEXECS	-	Left over work space in each section of reservoir calculations
NWLMAX	-	Unused
MISIBM	-	Double precision indicator - unused at present

LASTIN - End of permanent arrays in the blank common

COMMON /SIMPLE/

SWAT	-	Simple water property calculations indicator
DENWTR	-	Water density at reservoir conditions
CMPWTR	-	Water phase compressibility
VISWTR	-	Water viscosity

COMMON /SIMOIL/

DENOIL	-	Oil density at reservoir conditions
CMPOIL	-	Oil phase compressibility
VISOIL	-	Oil phase viscosity
DENOST	-	Oil density at standard conditions
DENWST	-	Water density at standard conditions
GORV	-	Gas oil ratio for economics
BOI	-	Oil formation volume factor at reservoir conditions
BWI	-	Water formation volume factor at reservoir conditions
APIV	-	API gravity of reservoir oil

COMMON /OPTION/

METH - Pressure solution method, always =1

COMMON /GRDSIZ/

NX	-	Number of grid cells per tube
NY	-	=1
NXNY	-	= NX
REFPRE	-	Reference pressure
DATUM	-	Unused
NZ	-	Number of layers
KZ	-	Layer for which the coefficients are being calculated
NXNYNZ	-	Number of cells per streamtube cross section

COMMON /CROCK/

CROCK - Pore volume compressibility

COMMON /COMSQZ/

NOSQZ	-	Unused
NSHRT	-	Unused
NLONG	-	Unused
IALONG	-	Unused
IASHRT	-	Unused
ISCZER	-	Start of flow coefficient storage at back of blank common
ISCPTR	-	Pointer for next flow coefficient to be stored
KSCPTR	-	Unused
LIMSCR	-	Limit of space in blank common for coefficients
NOARR	-	Unused

COMMON /RPORT4/

TOCUM	-	Total cumulative oil production
TWCUM	-	Total cumulative water production
TWICUM	-	Total cumulative water injection
TORAT	-	Total oil rate
TWRAT	-	Total water production rate
TWIRAT	-	Total water injection rate

COMMON /LOCAL/

ICUTC	-	Indicator for the time to save arrays for infill
OIPOR1	-	Original oil in place for non-infill
TOTKH	-	Total KH of the layers
VTUBE	-	Relative injection rates for each streamtube
TSTEP	-	Timestep
XNCSTP	-	Increment for output (0.1 pore volume)
XSTPR	-	Output increment counter
PVLY	-	Pore volume for each streamtube

COMMON /RSTART/

NSTEP	-	Timestep number at any time in reservoir calculation
NSTR	-	Timestep number at infill start
TAPE	-	Unused
KEEP	-	Timestep number at end of non-infill run
ISTRT	-	Unused
NSTART	-	Unused
TOPT	-	Unused
RESTSW	-	Unused

COMMON /TUBE/

NONODE	-	Number of nodes in finite element mesh
NOELEM	-	Number of elements in finite element mesh
X	-	X coordinate value of the nodes in the pressure and stream function calculations. These locations are where the steady state solution of pressures is performed in the "surface" routines. The values are then interpolated to the uniform pressure and stream arrays for calculation of stream tubes.

Y	-	Y coordinate value of the nodes in the pressure and stream function calculations (see above).
RATE	-	Specified source/sink term for calculation of steady state pressure distribution. Rates are only specified for the 1/8 and 1/4 comer wells for the element of symmetry of the 5 spot pattern.
PSPEC	-	Specified pressure for the calculation of steady state pressure distribution. Pressure at the center of the grid is specified, then based on input KX/KY ratio and the rate specification locations the steady state pressure distribution is calculated.
NODE	-	The nodes that form the comers of the triangle that makes up each element in the finite element solution
TRANS	-	Transmissibility of each element in the finite element solution. For the calculation of stream tubes the transmissibility is immaterial in that it effects the levels of the pressures but not the shapes of the tubes for homogeneous areal systems.
NNODE	-	List of the nodes that are connected to each node. ***Note:*** in the current code, no more than 10 nodes may be connected to any one node, i.e. no node can be in more than 10 elements.
TERM	-	Flow coefficient between each of the nodes that is connected, for use in the steady-state pressure solution
PRESUR	-	Pressure at each of the nodes from the steady-state finite element solution for pressure distribution
IMINGD	-	Minimum X-index for each of the JGDMAX grid rows
IMAXGD	-	Maximum X-index for each of the JGDMAX grid rows

COMMON /LSOR/

OMEG	-	LSOR overrelaxation parameter
TSATX	-	Unused
TSUMX	-	Unused
OMDIFF	-	Omega change value for next pressure solution iteration
OMBUG	-	Unused

COMMON /ANORM/

ANORM	-	Normalization vector in LSOR routine
IJKLOC	-	Cell pointer in solution routine

COMMON /SATCOM/

IFIRST	-	Beginning cell of each streamtube, =1
IFINAL	-	Last cell of each streamtube, =NX
IPRT	-	Unused
SWLHS	-	Unused
SOLHS	-	Unused
PVLHS	-	Unused
XPOIL	-	Unused
XPWAT	-	Unused
XPGAS	-	Unused
CPOOLD	-	Unused
CPWOLD	-	Unused
CPGOLD	-	Unused

J - =1
K - Layer for which calculations are done in subroutine OVER6
IJKO - Cell and layer pointer in saturation solution
CALSAT - Master pointer for doing saturation solution
IVF - Indicator for doing vertical flow calculations
GIPALT - Unused
QPTOT - Unused

COMMON /OL6VEX/

SYMAOE - Oil flow coefficient between a cell and cell to its right in a tube
SWMAWE - Water flow coefficient between a cell and cell to its right in a tube
SYMAGE - Gas coefficient, unused in current version
RHSO - Right hand side of known terms for oil equation
RHSW - Right hand side of known terms for water equation
RHSG - Gas coefficient, unused at present
RHSP - Unused
SYMAPE - Unused at present
DG - Gas property pointer, unused at present
NPVT - Fluid property pointer

COMMON /COFCOM/

J - =1
K - Layer for which coefficients are being set up
IJKO - Location of calculation within a streamtube cross section
IFIRST - First cell in tube, =1
IFINAL - Last active cell in a tube, =nx

COMMON /EMPCOM/

ISTART - = IFIRST
IFINIS - = IFINAL, would be different with 0 pore volume cells in a model

COMMON /OL4VEX/

OILRHS - Right hand side coefficient for oil saturation equation
WTRRHS - Right hand side coefficient for water saturation equation
GASRHS - Gas equation, unused at present
AOC - Center cell pressure coefficient
AWC - Center cell water pressure coefficient
AGC - Gas pressure coefficient, unused at present
AON - Oil equation pressure coefficient for cell in next streamtube, set to zero at present
AWN - Water equation pressure coefficient for cell in next streamtube, set to zero at present
AGN - Gas coefficient, unused at present
AOS - Oil pressure coefficient for last streamtube, unused
AWS - Water pressure coefficient for last streamtube, unused
AGS - Gas coefficient, unused at present
AOW - Oil pressure coefficient for flow from cell to left
AWW - Water pressure coefficient for flow from cell to left

AGW - Gas coefficient, unused at present
AOE - Oil pressure coefficient for flow to cell to right
AWE - Water pressure coefficient for flow to cell to right
AGE - Gas coefficient, unused at present
RPVODT - Pore volume cell pressure equation coefficient
XTRAN - Transmissibility between cells in a tube
YTRAN - Transmissibility between cells in last tube, unused
DELS - Potential gradient to cell in last tube, unused
DELE - Potential gradient to cell to right in tube
SO - Oil saturation
SW - Water saturation

COMMON /FILES/

METRIC - Not presently used, available for future extension to non-field units input and output
IR - Logical unit for input(5)
IW - Logical unit for tabular output (6)
IP - Logical unit for plot output (12)
IPOUT - Not used

SECTION 9
IDPM TREE STRUCTURE

The following tree structure of the IDPM source code was produced by SSI's PROFLOW program.

```
ROUTINE MAIN   CALLS THE FOLLOWING ROUTINES --

             OVER1   OVER2   OVER3   OVER4   OVER5
             OVER6   OVER7   CUTBCK  ECONID  HALTER

                    ROUTINE MAIN   IS CALLED BY THE FOLLOWING ROUTINES --


ROUTINE PROIL  CALLS THE FOLLOWING ROUTINES --


                    ROUTINE PROIL  IS CALLED BY THE FOLLOWING ROUTINES --

                          CUTBCK  ACHECK  EMPFUN  PVTFUN


ROUTINE PORE   CALLS THE FOLLOWING ROUTINES --


                    ROUTINE PORE   IS CALLED BY THE FOLLOWING ROUTINES --

                          ACHECK  SATSOL


ROUTINE REPLAC CALLS THE FOLLOWING ROUTINES --


                    ROUTINE REPLAC IS CALLED BY THE FOLLOWING ROUTINES --


ROUTINE SATDEP CALLS THE FOLLOWING ROUTINES --

             WATSAT

                     ROUTINE SATDEP IS CALLED BY THE FOLLOWING ROUTINES --

                          EMPFUN


ROUTINE WATPR  CALLS THE FOLLOWING ROUTINES --
```

ROUTINE WATPR IS CALLED BY THE FOLLOWING ROUTINES --

CUTBCK ACHECK

ROUTINE WATSAT CALLS THE FOLLOWING ROUTINES --

ROUTINE WATSAT IS CALLED BY THE FOLLOWING ROUTINES --

SATDEP CUTBCK RPTABL

ROUTINE ZEROS CALLS THE FOLLOWING ROUTINES --

ROUTINE ZEROS IS CALLED BY THE FOLLOWING ROUTINES --

INITAL LSOR2D OVER6 SATSOL

ROUTINE ECONID CALLS THE FOLLOWING ROUTINES --

INEC ECON OUTE

ROUTINE ECONID IS CALLED BY THE FOLLOWING ROUTINES --

MAIN

ROUTINE UOUT CALLS THE FOLLOWING ROUTINES --

ROUTINE UOUT IS CALLED BY THE FOLLOWING ROUTINES --

INEC OUTE

ROUTINE INEC CALLS THE FOLLOWING ROUTINES --

TITLE SDINT ECFTR CHEKE STCDE
UOUT

ROUTINE INEC IS CALLED BY THE FOLLOWING ROUTINES --

ECONID

ROUTINE STCDE CALLS THE FOLLOWING ROUTINES --

ROUTINE STCDE IS CALLED BY THE FOLLOWING ROUTINES --

INEC

ROUTINE CHEKE CALLS THE FOLLOWING ROUTINES --

SDINT CIND

ROUTINE CHEKE IS CALLED BY THE FOLLOWING ROUTINES --

```
                INEC

ROUTINE CIND   CALLS THE FOLLOWING ROUTINES --

                    ROUTINE CIND  IS CALLED BY THE FOLLOWING ROUTINES ––
                          CHEKE

ROUTINE ECFTR  CALLS THE FOLLOWING ROUTINES --

                    ROUTINE ECFTR  IS CALLED BY THE FOLLOWING ROUTINES --
                          INEC

ROUTINE ECON   CALLS THE FOLLOWING ROUTINES --
             NEWDCF
                    ROUTINE ECON   IS CALLED BY THE FOLLOWING ROUTINES ––
                          ECONID

ROUTINE OUTE   CALLS THE FOLLOWING ROUTINES --
             UOUT    TITLE
                    ROUTINE OUTE   IS CALLED BY THE FOLLOWING ROUTINES --
                          ECONID

ROUTINE SDINT  CALLS THE FOLLOWING ROUTINES --
                    ROUTINE SDINT  IS CALLED BY THE FOLLOWING ROUTINES --
                          INEC   CHEKE

ROUTINE TITLE  CALLS THE FOLLOWING ROUTINES --

                    ROUTINE TITLE  IS CALLED BY THE FOLLOWING ROUTINES --
                          INEC    OUTE

ROUTINE NEWDCF CALLS THE FOLLOWING ROUTINES --
             APRVAL
                    ROUTINE NEWDCF IS CALLED BY THE FOLLOWING ROUTINES –
```

ECON

ROUTINE APRVAL CALLS THE FOLLOWING ROUTINES --

ROUTINE APRVAL IS CALLED BY THE FOLLOWING ROUTINES -–

NEWDCF

ROUTINE CUTBCK CALLS THE FOLLOWING ROUTINES -–

PROIL WATPR WATSAT

ROUTINE CUTBCK IS CALLED BY THE FOLLOWING ROUTINES -–

MAIN

ROUTINE OVER1 CALLS THE FOLLOWING ROUTINES -–

INITAL SINGLE

ROUTINE OVER1 IS CALLED BY THE FOLLOWING ROUTINES –

MAIN

ROUTINE INITAL CALLS THE FOLLOWING ROUTINES -–

ZEROS

ROUTINE INITAL IS CALLED BY THE FOLLOWING ROUTINES –

OVER1

ROUTINE SINGLE CALLS THE FOLLOWING ROUTINES --

TITLR   DPLYR   HALTER   RPTABL   GENTUB

ROUTINE SINGLE IS CALLED BY THE FOLLOWING ROUTINES –-

OVER1

ROUTINE RPTABL CALLS THE FOLLOWING ROUTINES –-

WATSAT

ROUTINE RPTABL IS CALLED BY THE FOLLOWING ROUTINES --

SINGLE

ROUTINE TITLR CALLS THE FOLLOWING ROUTINES --

ROUTINE TITLR IS CALLED BY THE FOLLOWING ROUTINES --

SINGLE

```
ROUTINE DPLYR  CALLS THE FOLLOWING ROUTINES --

             ROOT3   ERFUNC

                   ROUTINE DPLYR  IS CALLED BY THE FOLLOWING ROUTINES --

                         SINGLE


ROUTINE CFUN   CALLS THE FOLLOWING ROUTINES --

             ERFUNC

                   ROUTINE CFUN   IS CALLED BY THE FOLLOWING ROUTINES --

                         ROOT3


ROUTINE FFUN   CALLS THE FOLLOWING ROUTINES --

             ERFUNC

                   ROUTINE FFUN   IS CALLED BY THE FOLLOWING ROUTINES --

                         ROOT3


ROUTINE ERFUNC CALLS THE FOLLOWING ROUTINES --


                   ROUTINE ERFUNC IS CALLED BY THE FOLLOWING ROUTINES --

                         DPLYR   CFUN   FFUN


ROUTINE ROOT3  CALLS THE FOLLOWING ROUTINES --

             CFUN    FFUN

                   ROUTINE ROOT3  IS CALLED BY THE FOLLOWING ROUTINES --

                         DPLYR
ROUTINE GENTUB CALLS THE FOLLOWING ROUTINES --

             GENFEL  FELSLV  GENFCG  MARKST  DEFTUB

             DEFFDC  GENMCP

                   ROUTINE GENTUB IS CALLED BY THE FOLLOWING ROUTINES --

                         SINGLE


ROUTINE GENFEL CALLS THE FOLLOWING ROUTINES --

             PATTRN  NODDEF  NODNET  HALTER

                   ROUTINE GENFEL IS CALLED BY THE FOLLOWING ROUTINES --

                         GENTUB
```

ROUTINE NODDEF CALLS THE FOLLOWING ROUTINES --

HALTER

ROUTINE NODDEF IS CALLED BY THE FOLLOWING ROUTINES --

GENFEL

ROUTINE NODNET CALLS THE FOLLOWING ROUTINES --

ROUTINE NODNET IS CALLED BY THE FOLLOWING ROUTINES --

GENFEL

ROUTINE PATTRN CALLS THE FOLLOWING ROUTINES --

ROUTINE PATTRN IS CALLED BY THE FOLLOWING ROUTINES --

GENFEL

ROUTINE FELSLV CALLS THE FOLLOWING ROUTINES --

ROUTINE FELSLV IS CALLED BY THE FOLLOWING ROUTINES --

GENTUB

ROUTINE GENFCG CALLS THE FOLLOWING ROUTINES --

HALTER

ROUTINE GENFCG IS CALLED BY THE FOLLOWING ROUTINES --

GENTUB

ROUTINE MARKST CALLS THE FOLLOWING ROUTINES --

HALTER MARKSL FOLLSL TUBAUS

ROUTINE MARKST IS CALLED BY THE FOLLOWING ROUTINES --

GENTUB

ROUTINE FOLLSL CALLS THE FOLLOWING ROUTINES --

MARKSL EXTEND HALTER

ROUTINE FOLLSL IS CALLED BY THE FOLLOWING ROUTINES --

MARKST

ROUTINE EXTEND CALLS THE FOLLOWING ROUTINES --

MARKSL

ROUTINE EXTEND IS CALLED BY THE FOLLOWING ROUTINES --

FOLLSL

ROUTINE MARKSL CALLS THE FOLLOWING ROUTINES --

ROUTINE MARKSL IS CALLED BY THE FOLLOWING ROUTINES --

MARKST FOLLSL EXTEND

ROUTINE DEFTUB CALLS THE FOLLOWING ROUTINES --

SEARCH TUBAUS

ROUTINE DEFTUB IS CALLED BY THE FOLLOWING ROUTINES --

GENTUB

ROUTINE SEARCH CALLS THE FOLLOWING ROUTINES --

HALTER

ROUTINE SEARCH IS CALLED BY THE FOLLOWING ROUTINES --

DEFTUB

ROUTINE TUBAUS CALLS THE FOLLOWING ROUTINES --

ROUTINE TUBAUS IS CALLED BY THE FOLLOWING ROUTINES --

MARKST DEFTUB DEFFDC

ROUTINE DEFFDC CALLS THE FOLLOWING ROUTINES --

HALTER UTLSRX TUBAUS

ROUTINE DEFFDC IS CALLED BY THE FOLLOWING ROUTINES --

GENTUB

ROUTINE UTLSRX CALLS THE FOLLOWING ROUTINES --

ROUTINE UTLSRX IS CALLED BY THE FOLLOWING ROUTINES --

DEFFDC

ROUTINE GENMCP CALLS THE FOLLOWING ROUTINES --

```
                    ROUTINE GENMCP IS CALLED BY THE FOLLOWING ROUTINES --

                          GENTUB


ROUTINE OVER2  CALLS THE FOLLOWING ROUTINES --

             ACHECK

                    ROUTINE OVER2  IS CALLED BY THE FOLLOWING ROUTINES --

                          MAIN


ROUTINE ACHECK CALLS THE FOLLOWING ROUTINES --

             GRIDCH  GRIDC3  GRIDC2  GRIDC1  PORE
             PROIL  WATPR

                    ROUTINE ACHECK IS CALLED BY THE FOLLOWING ROUTINES --

                          OVER2


ROUTINE GRIDCH CALLS THE FOLLOWING ROUTINES --


                    ROUTINE GRIDCH IS CALLED BY THE FOLLOWING ROUTINES --

                          ACHECK


ROUTINE GRIDC1 CALLS THE FOLLOWING ROUTINES --


                    ROUTINE GRIDC1 IS CALLED BY THE FOLLOWING ROUTINES --

                          ACHECK


ROUTINE GRIDC2 CALLS THE FOLLOWING ROUTINES --


                    ROUTINE GRIDC2 IS CALLED BY THE FOLLOWING ROUTINES --

                          ACHECK


ROUTINE GRIDC3 CALLS THE FOLLOWING ROUTINES --


                    ROUTINE GRIDC3 IS CALLED BY THE FOLLOWING ROUTINES --

                          ACHECK

ROUTINE OVER3 CALLS THE FOLLOWING ROUTINES --
```

ROUTINE OVER3 IS CALLED BY THE FOLLOWING ROUTINES -–

MAIN

ROUTINE OVER4 CALLS THE FOLLOWING ROUTINES --

EMPFUN WTRFUN INICOF OILCOF WTRCOF
FINCOF

ROUTINE OVER4 IS CALLED BY THE FOLLOWING ROUTINES

MAIN

ROUTINE EMPFUN CALLS THE FOLLOWING ROUTINES --

PROIL   SATDEP

ROUTINE EMPFUN IS CALLED BY THE FOLLOWING ROUTINES --

OVER4

ROUTINE WTRFUN CALLS THE FOLLOWING ROUTINES --

ROUTINE WTRFUN IS CALLED BY THE FOLLOWING ROUTINES --

OVER4

ROUTINE INICOF CALLS THE FOLLOWING ROUTINES --

ROUTINE INICOF IS CALLED BY THE FOLLOWING ROUTINES --

OVER4

ROUTINE OILCOF CALLS THE FOLLOWING ROUTINES --

ROUTINE OILCOF IS CALLED BY THE FOLLOWING ROUTINES --

OVER4

ROUTINE WTRCOF CALLS THE FOLLOWING ROUTINES --

ROUTINE WTRCOF IS CALLED BY THE FOLLOWING ROUTINES –

OVER4

```
ROUTINE FINCOF CALLS THE FOLLOWING ROUTINES –
             GETWEL  SYMOUT
                    ROUTINE FINCOF IS CALLED BY THE FOLLOWING ROUTINES --
                          OVER4

ROUTINE SYMOUT CALLS THE FOLLOWING ROUTINES --

                    ROUTINE SYMOUT IS CALLED BY THE FOLLOWING ROUTINES –-
                          FINCOF

ROUTINE GETWEL CALLS THE FOLLOWING ROUTINES --

                    ROUTINE GETWEL IS CALLED BY THE FOLLOWING ROUTINES --
                          FINCOF

ROUTINE OVER5  CALLS THE FOLLOWING ROUTINES --
             OVER51
                    ROUTINE OVER5  IS CALLED BY THE FOLLOWING ROUTINES --
                          MAIN

ROUTINE LSOR2D CALLS THE FOLLOWING ROUTINES -–
             ZEROS   TRIDIA   OPTMIZ
                    ROUTINE LSOR2D IS CALLED BY THE FOLLOWING ROUTINES --
                          OVER51

ROUTINE TRIDIA CALLS THE FOLLOWING ROUTINES --

                    ROUTINE TRIDIA IS CALLED BY THE FOLLOWING ROUTINES -–
                          LSOR2D

ROUTINE OPTMIZ CALLS THE FOLLOWING ROUTINES --

                    ROUTINE OPTMIZ IS CALLED BY THE FOLLOWING ROUTINES --
                          LSOR2D
```

ROUTINE OVER51 CALLS THE FOLLOWING ROUTINES --

LSOR2D

ROUTINE OVER51 IS CALLED BY THE FOLLOWING ROUTINES --

OVER5

ROUTINE OVER6 CALLS THE FOLLOWING ROUTINES --

INISAT ZEROS SATSOL

ROUTINE OVER6 IS CALLED BY THE FOLLOWING ROUTINES --

MAIN

ROUTINE INISAT CALLS THE FOLLOWING ROUTINES --

ROUTINE INISAT IS CALLED BY THE FOLLOWING ROUTINES --

OVER6

ROUTINE PVTFUN CALLS THE FOLLOWING ROUTINES --

PROIL

ROUTINE PVTFUN IS CALLED BY THE FOLLOWING ROUTINES --

SATSOL

ROUTINE SATSOL CALLS THE FOLLOWING ROUTINES --

SYMINN ZEROS PVTFUN PORE PUTWEL

ROUTINE SATSOL IS CALLED BY THE FOLLOWING ROUTINES --

OVER6

ROUTINE PUTWEL CALLS THE FOLLOWING ROUTINES --

ROUTINE PUTWEL IS CALLED BY THE FOLLOWING ROUTINES --

SATSOL

ROUTINE SYMINN CALLS THE FOLLOWING ROUTINES --

ROUTINE SYMINN IS CALLED BY THE FOLLOWING ROUTINES --

```
ROUTINE OVER7  CALLS THE FOLLOWING ROUTINES --

             REPORT

                    ROUTINE OVER7  IS CALLED BY THE FOLLOWING ROUTINES --

                          MAIN


ROUTINE REPORT CALLS THE FOLLOWING ROUTINES --


                    ROUTINE REPORT IS CALLED BY THE FOLLOWING ROUTINES --

                          OVER7

ROUTINE HALTER CALLS THE FOLLOWING ROUTINES --


                    ROUTINE HALTER IS CALLED BY THE FOLLOWING ROUTINES --

                          MAIN    SINGLE  GENFEL  NODDEF  GENFCG
                          MARKST  FOLLSL  SEARCH  DEFFDC
```

```
                                                      MAIN
OVER1
     INITAL
          ZEROS
     SINGLE
          TITLR
          DPLYR
               ROOT3
                    CFUN
                         ERFUNC
                    FFUN
                         ERFUNC
               ERFUNC
          HALTER
          RPTABL
               WATSAT
          GENTUB
               GENFEL
                    PATTRN
                    NODDEF
                         HALTER
                    NODNET
                    HALTER
               FELSLV
               GENFCG
                    HALTER
               MARKST
                    HALTER
                    MARKSL
                    FOLLSL
                         MARKSL
                         EXTEND
                              MARKSL
                         HALTER
                    TUBAUS
               DEFTUB
                    SEARCH
                         HALTER
                    TUBAUS
               DEFFDC
                    HALTER
                    UTLSRX
                    TUBAUS
               GENMCP
OVER2
     ACHECK
          GRIDCH
          GRIDC3
          GRIDC2
          GRIDC1
          PORE
          PROIL
          WATPR
OVER3
OVER4
     EMPFUN
          PROIL
          SATDEP
               WATSAT
     WTRFUN
     INICOF
     OILCOF
     WTRCOF
     FINCOF
```

```
              GETWEL
              SYMOUT
OVER5
       OVER51
              LSOR2D
                     ZEROS
                     TRIDIA
                     OPTMIZ
OVER6
       INISAT
       ZEROS
       SATSOL
              SYMINN
              ZEROS
              PVTFUN
                     PROIL
              PORE
              PUTWEL
OVER7
       REPORT
CUTBCK
       PROIL
       WATPR
       WATSAT
ECONID
       INEC
              TITLE
              SDINT
              ECFTR
              CHEKE
                   SDINT
                   CIND
              STCDE
              UOUT
       ECON
              NEWDCF
                     APRVAL
       OUTE
              UOUT
              TITLE
       HALTER
FORTRAN STOP
```

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APPENDIX 1a
IDPM INPUT/OUTPUT FOR IDPM VERIFICATION AGAINST BLACK-OIL SIMULATION

```
                         SCIENTIFIC  SOFTWARE
                             -   INTERCOMP

                    INFILL DRILLING PREDICTION MODEL
                         (IDPM - RELEASE 1.2.0)


IDPM DATA - VERSION 1.2 TEST: Verification Against SimBest II
   IDPM DATA - VERSION 1.2 TEST: Verification Against SimBest II
   0, 1, 1, 0, 0, 0.83
   1, 4, 15, 1, .01, 1
   80., 300.0, 1320., 0.95, 200., 400., .60, 0.90, 0.
   .000003, 3000., 3000., -6500., 117.
   64.00, 1.0001, .000003,   .6,   0.8
   32.00, 1.25, .00000735, 1.2, 300.
   2., 2., .8, .2, .3, .24, 0.
   1
   .063, .65, 250.


I D P M  CURRENT MAXIMUM PARAMETER VALUES

   NUMBER OF TUBES PER LAYER                               16
   NUMBER OF GRID CELLS PER TUBE                           15
   NUMBER OF LAYERS                                        20
   NUMBER OF TIMESTEPS IN RESERVOIR RUN                  5000
   BLANK COMMON SIZE  FOR RESERVOIR                     10000
   NUMBER OF YEARS FOR ECONOMIC ANALYSIS                   50


SPECIFIED PRINTOUT CONTROLS

   RESERVOIR ARRAY OUTPUT CONTROL                      0   IARRP
   RESERVOIR ANALYSIS OUTPUT CONTROL                   1   IANALP
   STREAMTUBE OUTPUT CONTROL                           1   ISTRMP
   ECONOMIC ANALYSIS CONTROL(0-NO, 1-YES)              0   IECONR


RESERVOIR PROPERTIES OUTPUT

   FORMATION DEPTH -- SUBSURFACE              -6500.0    FEET
   FORMATION TEMPERATURE                        117.0    DEG F
   INDIVIDUAL PATTERN AREA                       80.0    ACRES
   KV/KH VERTICAL TO HORIZONTAL PERM            0.010
   KY/KX ANISOTROPIC VALUE (1.0-100.0)          1.000
   DYKSTRA-PARSONS  COEFFICIENT                  0.83    VDP
   PRESSURE AT FORMATION TOP                    3000.0     PSIA
   PORE VOLUME COMPRESSIBILITY             0.00000300     1/PSI
   REFERENCE PRESSURE (POROSITY MEASURED)      3000.0       PSIA
   NUMBER OF LAYERS                                 4
   STREAMTUBES PER LAYER                           12
   NUMBER OF GRID CELLS PER STREAMTUBE             15
   INFILL PATTERN (0=5-SPOT, 1=09-SPOT              1

              PROPERTIES BY LAYER

POROSITY          X-DIR PERM             NET PAY
  0.0630              2.25                  62.50
  0.0630              0.25                  62.50
```

0.0630	0.08	62.50
0.0630	0.02	62.50

WATER DENSITY AT STANDARD CONDITIONS	64.00	LB/CUFT
WATER DENSITY AT RESERVOIR CONDITIONS	63.99	LB/CUFT
WATER FORMATION VOLUME FACTOR	1.00	VOL/VOL
WATER COMPRESSIBILITY AT RES. COND.	0.00000300	1/PSI
WATER VISCOSITY AT RES. COND	0.60	CP

OIL DENSITY AT STANDARD CONDITIONS	54.00	LB/CUFT
OIL GRAVITY	32.0	DEG API
OIL DENSITY AT RESERVOIR CONDITIONS	43.20	LB/CUFT
OIL FORMATION VOLUME FACTOR	1.25	VOL/VOL
OIL COMPRESSIBILITY AT RES. COND.	0.00000735	1/PSI
OIL VISCOSITY AT RES. COND	1.20	CP
SOLUTION GAS-OIL-RATIO	300.0	SCF/STB
GAS GRAVITY (AIR=1.0)	0.800	

INJECTION RATE (NON-INFILL)	300.0	STBW/D
INJECTION RATE (INFILL, MAY BE 0.0)	400.0	STBW/D
WATER CUT AT INFILL (VCUT)	0.600	FRAC.
WATER CUT AT END (CUTMAX)	0.900	FRAC.
PLUG BACK AT INFILL (1=NO, 2=YES, IF LAYER W-CUT .GT. VCUT)	1	

RELATIVE PERMEABILITY DATA

IRREDUCIBLE WATER SATURATION	0.300	SWC
RESIDUAL OIL SATN -- INPUT --	0.240	SORW
OIL RELATIVE PERM END-POINT	0.800	XKROE
WATER RELATIVE PERM END-POINT	0.200	SKRWE
OIL RELATIVE PERM CURVATURE	2.00	XNO
WATER RELATIVE PERM CURVATURE	2.00	XNW
(MAX) WELL DIST. FOR CONN.=100%	300.000	VWD100
WELL DIST. FOR CONN.=VCONEC	1320.000	VDBWLS
RESERVOIR CONNECTIVITY AT VDBWLS	0.950	VCONEC

RELATIVE PERMEABILITY TABLE FOR CONNECTIVITY = 1.00000

WATER SATURATN	OIL KRO	WATER KRW	FW (FR FLOW)	D(FW) / D(SW)
0.3000	0.8000	0.0000	0.000	
0.3230	0.7220	0.0005	0.001	0.060
0.3460	0.6480	0.0020	0.006	0.207
0.3690	0.5780	0.0045	0.015	0.400
0.3920	0.5120	0.0080	0.030	0.651
0.4150	0.4500	0.0125	0.053	0.971
0.4380	0.3920	0.0180	0.084	1.369
0.4610	0.3380	0.0245	0.127	1.848
0.4840	0.2880	0.0320	0.182	2.400
0.5070	0.2420	0.0405	0.251	2.998
0.5300	0.2000	0.0500	0.333	3.590
0.5530	0.1620	0.0605	0.428	4.097
0.5760	0.1280	0.0720	0.529	4.428
0.5990	0.0980	0.0845	0.633	4.502
0.6220	0.0720	0.0980	0.731	4.278
0.6450	0.0500	0.1125	0.818	3.776
0.6680	0.0320	0.1280	0.889	3.074
0.6910	0.0180	0.1445	0.941	2.282
0.7140	0.0080	0.1620	0.976	1.502
0.7370	0.0020	0.1805	0.994	0.808
0.7600	0.0000	0.2000	1.000	0.240

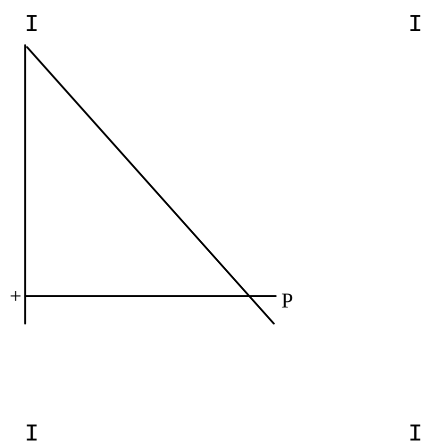
FW = MOBW / (MOBW+MOBO), WHERE MOBW = KRW/VISW, MOBO = KRO/VISO

PROPERTIES BY LAYER

POROSITY	X-DIR PERM	NET PAY	SO	SW
0.0630	2.25	62.50	0.7000	0.3000
0.0630	0.25	62.50	0.7000	0.3000
0.0630	0.08	62.50	0.7000	0.3000
0.0630	0.02	62.50	0.7000	0.3000

N O N - I N F I L L S I M U L A T I O N

SYMMETRY ELEMENT WITHIN 5-SPOT, BEFORE IN-FILL
ISOTROPIC PERMEABILITY CASE - 1/8



FRACTIONAL WELL RATES FOR TUBE CALCULATIONS
PRODUCER = .10000E+01
INJECTOR = -0.10000E+01

INJECTOR AT COORD (1, 65)
PRODUCER AT COORD (65, 1)
STREAM TUBES

```
1
19
35C
168C
149AC
1378BC
2457ABC
13679ABC
124689BCC
124578ABCC
1245689ABCC
12356789ABCC
12346789ABBCC
123456789ABCCC
1234567899ABCCC
1234567789AABCCC
12345567899ABBCCC
12344567889AABBCCC
113345677899AABCCCC
1133455678899ABBCCCC
1123455677889AABBCCCC
11234456678899AABBCCCC
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112344566778899AABBCCCC
112344556 778899AABBBCCCC
1123344556778899AABBBCCCC
11233445566778899AABBBCCCC
11233445566778899AAABBBCCCC
112334455667788899AAABBBCCCC
1123344556667788999AAABBBCCCC
11233344556677788999AAABBBCCCC
112233445566677888999AABBBBCCCC
1122334445566777888899AAABBBBC CCC
11223334455666777888999AAABBBCCCCC
112233344555666777888999AAABBBCCCCC
1122233444556666777888999AAABBBBCCCC
11222333445556667778888999AAABBBBCCCC
112223334445566677777888999AAABBBBCCCC
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11222333344455566677788889 99AAABBBBCCCC
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1112223333444555566677778888999AAAABBBCCCC
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1111222233334444455556666677778888999AAABBBCCCC
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111122222333333444444555556666667777888899AAABBCCCC
11111222233333344444555556666677 777888999AAABBCCCC
1111122222333333344444555555666667777888899AABBBCCC
111112222233333334444445555556666677777888899AAABBCCC
1111112222223333333344444445555556666677777888999AABBCCC
11111122222223333333334444444455555566666677777788899AABBCCC
111111122222233333 3333444444444555555666667777888999AABBCC
1111111122222222333333333444444444555555666666777888999ABBCC
11111111222222222233333333333444444444555555666677788899AABCC
1111111111122222222222333333333333444444445555556667777889ABCC
1111111111112222222222223333333333334444444 455555666777889AABC
11111111111112222222222222223333333333334444444444444466677889ABC
1111111111111111112222222222222222223333333333344444444555667789AAC
11111111111111111111122222222222222222223333333333333444444556788BB
11111111111111111111111111111222222222222222222222 3333333344456779C
111111111111111111111111111111111111111111111112222222222234343568
11111111111111111111111111111111111111111111111122111111111112121212
```

RELATIVE PERMEABILITY TABLE FOR CONNECTIVITY = 0.95000

WATER SATURATN	OIL KRO	WATER KRW	FW (FR FLOW)	D(FW) / D(SW)
0.3000	0.8000	0.0000	0.000	
0.3230	0.7180	0.0006	0.002	0.067
0.3460	0.6404	0.0022	0.007	0.232
0.3690	0.5673	0.0050	0.017	0.452
0.3920	0.4986	0.0089	0.034	0.742
0.4150	0.4343	0.0139	0.060	1.114
0.4380	0.3745	0.0199	0.096	1.578
0.4610	0.3191	0.0271	0.145	2.137
0.4840	0.2681	0.0355	0.209	2.772
0.5070	0.2216	0.0449	0.288	3.439
0.5300	0.1795	0.0554	0.382	4.062
0.5530	0.1418	0.0670	0.486	4.533
0.5760	0.1086	0.0798	0.595	4.743
0.5990	0.0798	0.0936	0.701	4.618
0.6220	0.0554	0.1086	0.797	4.152
0.6450	0.0355	0.1247	0.875	3.423
0.6680	0.0199	0.1418	0.934	2.557
0.6910	0.0089	0.1601	0.973	1.685
0.7140	0.0022	0.1795	0.994	0.904
0.7370	0.0000	0.2000	1.000	0.267

0.7600	0.0000	0.2216	1.000	0.000

FW = MOBW / (MOBW+MOBO), WHERE MOBW = KRW/VISW, MOBO = KRO/VISO

SIMULATED FLOODING OF SYMMETRY ELEMENT STREAM TUBES

(ALL VOLUMES/RATES GIVEN BELOW ARE FOR THE SYMMETRY ELEMENT WHICH HAS 1.0/8.0 OF THE AREA OF THE PRE-INFILL 5-SPOT.)

		--------IN - PLACE - VOLUMES--------		
LAYER	TUBE	OIL (SCF)	WATER (SCF)	PORE VOL. (RCF)
1	1	0.13368E+06	0.71602E+05	0.23869E+06
2	1	0.13370E+06	0.71610E+05	0.23870E+06
3	1	0.13373E+06	0.71618E+05	0.23872E+06
4	1	0.13375E+06	0.71626E+05	0.23873E+06
1	2	0.10190E+06	0.54581E+05	0.18195E+06
2	2	0.10192E+06	0.54587E+05	0.18196E+06
3	2	0.10194E+06	0.54593E+05	0.18197E+06
4	2	0.10196E+06	0.54599E+05	0.18198E+06
1	3	0.10671E+06	0.57156E+05	0.19053E+06
2	3	0.10673E+06	0.57162E+05	0.19054E+06
3	3	0.10675E+06	0.57169E+05	0.19056E+06
4	3	0.10677E+06	0.57175E+05	0.19057E+06
1	4	0.87710E+06	0.46981E+05	0.15661E+06
2	4	0.87727E+05	0.46986E+05	0.15662E+06
3	4	0.87744E+05	0.46992E+15	0.15663E+06
4	4	0.87761E+05	0.46997E+05	0.15667E+06
1	5	0.74108E+05	0.39695E+05	0.13233E+06
2	5	0.74122E+05	0.39700E+05	0.13233E+06
3	5	0.74137E+05	0.39704E+05	0.13234E+06
4	5	0.74151E+05	0.39709E+05	0.13235E+06
1	6	0.71294E+05	0.38188E+05	0.12730E+06
2	6	0.71308E+05	0.38192E+05	0.12731E+06
3	6	0.71322E+05	0.38196E+05	0.12732E+06
4	6	0.71335E+05	0.38201E+05	0.12732E+06
1	7	0.69418E+05	0.37183E+05	0.12395E+06
2	7	0.69431E+05	0.37187E+05	0.12396E+06
3	7	0.69445E+05	0.37191E+05	0.12397E+06
4	7	0.69458E+05	0.37195E+05	0.12397E+06
1	8	0.65431E+05	0.35047E+05	0.11683E+06
2	8	0.65444E+05	0.35051E+05	0.11684E+06
3	8	0.65456E+05	0.35055E+05	0.11685E+06
4	8	0.65469E+05	0.35059E+05	0.11685E+06
1	9	0.59333E+05	0.31781E+05	0.10595E+06
2	9	0.59345E+05	0.31785E+05	0.10595E+06
3	9	0.59356E+05	0.31788E+05	0.10596E+06
4	9	0.59368E+05	0.31792E+05	0.10596E+06
1	10	0.57692E+05	0.30902E+05	0.10301E+06
2	10	0.57703E+05	0.30905E+05	0.10302E+06
3	10	0.57714E+05	0.30909E+05	0.10303E+06
4	10	0.57725E+05	0.30912E+05	0.10303E+06
1	11	0.60741E+05	0.32535E+05	0.10846E+06
2	11	0.60752E+05	0.32539E+05	0.10846E+06
3	11	0.60764E+05	0.32542E+05	0.10847E+06
4	11	0.60776E+05	0.32546E+05	0.00848E+06
1	12	0.72701E+05	0.38941E+05	0.12981E+06
2	12	0.72715E+05	0.38946E+05	0.12982E+06
3	12	0.72729E+05	0.38950E+05	0.12983E+06
4	12	0.72743E+05	0.38955E+05	0.12984E+06
TOTALS		0.38439E+07	0.20587E+07	0.68623E+07
(M-STB)		684.58	366.65	

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
0.4	138.2	138.246	1	1

PRODUCTION/INJECTION RATE (STB/D)

OIL	WATER	INJECTION
15.15	0.94683-11	25.00

CUMULATIVE PRODUCTION/INJECTION (STB)

OIL	WATER	INJECTION
2095.	0.1309E-08	3457

CURRENT IN-PLACE-VOLUMES

OIL (MSTB)	WATER (MSTB)
682.49	370.10

MAXIMUM PRESSURE

3430.2

MATERIAL BALANCE ERROR

OIL	WATER
1.0000	1.0000

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
0.8	276.5	138.246	2	2

```
PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL     WATER     INJECTION             OIL     WATER       INJECTION
     17.91   0.4871E-05  25.00               4570.   0.6734E-03   6914

     CURRENT IN-PLACE-VOLUMES                            MAXIMUM
OIL (MSTB)         WATER (MSTB)                         PRESSURE
 680.02              373.56                               3641.8

     MATERIAL BALANCE ERROR
OIL                WATER
1.0000             1.0000
```

PERIODIC REPORT ON STATUS OF SIMULATION

```
           YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
           13.6       4976.8    138.246        36                 36

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL     WATER     INJECTION             OIL     WATER       INJECTION
     14.15   7.058       25.00             0.9393E+05  4006.       0.1244E+06

     CURRENT IN-PLACE-VOLUMES                            MAXIMUM
OIL (MSTB)         WATER (MSTB)                         PRESSURE
 590.59              487.05                               4100.5

     MATERIAL BALANCE ERROR
  OIL              WATER
0.99989            0.99998
```

PERIODIC REPORT ON STATUS OF SIMULATION

```
           YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
           17.8       6497.5    138.246        47                 47

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL     WATER     INJECTION             OIL     WATER       INJECTION
     8.949   13.61       25.00             0.1097E+06  0.2209E+05  0.1625E+06

     CURRENT IN-PLACE-VOLUMES                            MAXIMUM
OIL (MSTB)         WATER (MSTB)                         PRESSURE
 574.78              507.02                               4069.7

     MATERIAL BALANCE ERROR
  OIL              WATER
0.99983            1.0001
```

CONTINUATION OF WATERFLOOD AFTER WATER CUT FOR INFILL

PERIODIC REPORT ON STATUS OF SIMULATION

```
           YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
           18.2       6635.8    138.246        1                  48

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL     WATER     INJECTION             OIL     WATER       INJECTION
     8.778   13.74       25.00             0.1109E+06  0.2399E+05  0.1659E+06

     CURRENT IN-PLACE-VOLUMES                            MAXIMUM
OIL (MSTB)         WATER (MSTB)                         PRESSURE
 573.56              508.58                               4067.8

     MATERIAL BALANCE ERROR
  OIL              WATER
```

OIL	WATER
0.99983	1.0001

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
26.9	9815.4	138.246	24	71

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
4.573	19.33	25.00	0.1301E+06	0.7943E+05	0.2454E+06

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
554.27	532.91	4230.8

MATERIAL BALANCE ERROR	
OIL	WATER
0.99959	1.0008

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
40.5	14792.3	138.246	60	107

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
3.952	20.07	25.00	0.1510E+06	0.1779E+06	0.3699E+06

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
533.02	559.45	4186.2

MATERIAL BALANCE ERROR	
OIL	WATER
0.99910	1.0022

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
53.7	19630.9	138.246	95	142

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
3.619	20.48	25.00	0.1692E+16	0.2760E+06	0.4909E+06

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
514.50	582.61	4169.5

MATERIAL BALANCE ERROR	
OIL	WATER
0.99874	1.0032

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
67.0	24469.5	138.246	130	177

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
3.287	20.90	25.00	0.1860E+06	0.3761E+06	0.6119E+06

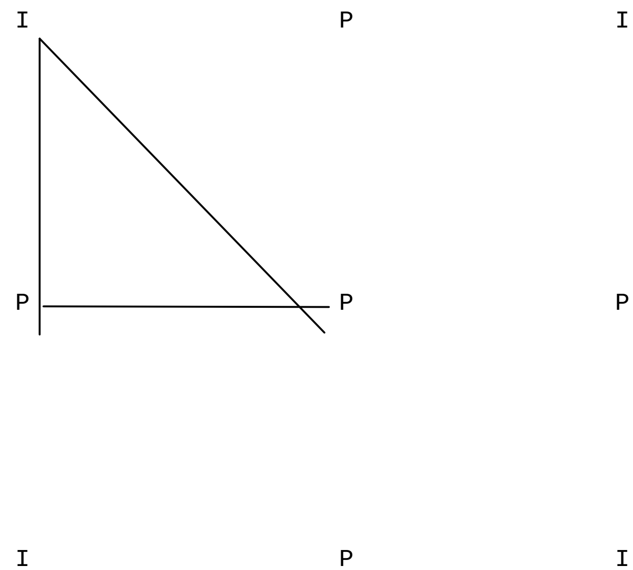
```
     CURRENT IN-PLACE-VOLUMES                                 MAXIMUM
OIL (MSTB)        WATER (MSTB)                               PRESSURE
 497.60             603.81                                     4163.9

     MATERIAL BALANCE ERROR
 OIL              WATER
0.99845           1.0040
```

PERIODIC REPORT ON STATUS OF SIMULATION

```
           YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
           80.6       29446.4   138.246        166                213

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL      WATER     INJECTION              OIL      WATER       INJECTION
     2.758    21.55       25.00           0.2011E+06 0.4817E+06 0.7363E+06

     CURRENT IN-PLACE-VOL UMES                                MAXIMUM
OIL (MSTB)        WATER (MSTB)                               PRESSURE
 482.34             622.97                                     4163.5

     MATERIAL BALANCE ERROR
 OIL              WATER
0.99826           1.0047


*********************

TIME STEPS EXECUTED        235
GRID-CELL-TIME STEPS    676800
```

INFILL SIMULATION

SYMMETRY ELEMENT AFTER 9-SPOT IN-FILL ISOTROPIC PERMEABILITY CASE - 1/8




```
FRACTION WELL RATES FOR TUBE CALCULATIONS
              NEW PRODUCER     =   0.666003+00
              OLD PRODUCER     =   0.33400E+00
              INJECTOR         =  -0.10000E+01

 INJECTOR AT COORD (  1, 65 )
 PRODUCER AT  COORD ( 65,  1 )
 PRODUCER AT COORD (  1,  1 )
```

STREAMTUBES

```
1
1B
27C
158C
139AC
1468BC
23679BC
13479BBC
135789ACC
124578ABCC
1345689ABCC
12356789ABCC
12346789ABBCC
123456789ABCCC
1234567899ABCCC
1234567789ABBCCC
12345567899ABBCCC
12344567889AABBCCC
113345677899AABCCCC
113345667889AABBCCCC
1123455677899AABBCCCC
11234456778899AABBCCCC
11234456677899AABBBCCCC
112344556778899AABBBCCCC
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112344556778899AAABBBCCCC
1123345566778899AAABBBCCCC
11233445667788999AABBBCCCCC
1123344556677889 9A AABBBCCCCC
112334455667788999AAABBBCCCCC
1123344556677788999AAABBBCCCCC
1123344556667788899AAABBBCCCCCC
1123334455667788899 9AAABBBCCCCCC
1123334455667778889 9AAAABBBCCCCCC
112233445566677888999AAABBBBCCCCCC
1122334455666777888999AAABBBBCCCCCC
11223344555667778889 99AAABBBBBCCCCCC
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1122334445566677788899 9AAAABBBBBCCCCCCC
11223334455666777888899 9AAAABBBBBCCCCCCC
11223334455566677788899 9AAAAABBBBBCCCCCCC
112233344555666777 8 889999AAAABBBBBCCCCCCCC
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1123344555666677777888889999999AAAAAAAAABBBBBBBCCCCCCC
11233445556667777788888899999999AAAAAAAAAABBBBBBBCCCCCC
112344555666677777888 8 899999999999AAAAAAAAAAABBBBBBCCCCCC
1133445566667777788888888999999999999AAAAAAAAAAAABBBBBBBCCCCC
22244556666777778888888889999999999999AAAAAAAAAAAABBBBBBCCCCC
12344566667777788888888888999999999999999AAAAAAAAAAAAAABBBBBCCCC
1234566677777788888888888899999999999999 999999AAAAAAAAAAAABBBBCCCC
134566777778888888888888889999999999999999999999AAAAAAAAAAAAABBBCCC
2456777778888888888888888899999999999999999999999999999AAAAAAABBBCC
14677888888888888888888888899999999999999999999999999999999999AAAAAABC
188888888888888888888888889999999999 99999999999999999999999999999A9
```

<u>RELATIVE PERMEABILITY TABLE FOR CONNECTIVITY = 0.96865</u>

WATER SATURATN	OIL KRO	WATER KRW	FW (FR FLOW)	D(FW) / D(SW)
0.3000	0.8000	0.0000	0.00	
0.3230	0.7195	0.0005	0.001	0.064
0.3460	0.6433	0.0021	0.007	0.222
0.3690	0.5714	0.0048	0.017	0.432
0.3920	0.5037	0.0085	0.033	0.706
0.4150	0.4403	0.0133	0.057	1.057
0.4380	0.3812	0.0192	0.091	1.495
0.4610	0.3263	0.0261	0.138	2.022
0.4840	0.2757	0.0341	0.198	2.625
0.5070	0.2294	0.0432	0.273	3.267
0.5300	0.1873	0.0533	0.363	3.880
0.5530	0.1494	0.0645	0.463	4.370
0.5760	0.1159	0.0767	0.570	4.634
0.5990	0.0866	0.0901	0.675	4.591
0.6220	0.0615	0.1044	0.855	4.221
0.6450	0.0408	0.1199	0.918	3.577
0.6680	0.0243	0.1364	0.962	2.768
0.6910	0.0120	0.1540	0.988	1.918
0.7140	0.0040	0.1727	0.999	1.131
0.7370	0.0003	0.1924	1.000	0.467
0.7600	0.0000	0.2132		0.033

FW = MOBW / (MOBW+MOBO), WHERE MOBW = KRW/VISW, MOBO = KRO/VISO

SIMULATED FLOODING OF SYMMETRY ELEMENT STREAM TUBES

(ALL VOLUMES/RATES GIVEN BELOW ARE FOR THE SYMMETRY ELEMENT WHICH HAS 1.0/8.0 OF THE AREA OF THE PRE-INFILL 5-SPOT.)

		----IN - PLACE - VOLUMES----		
LAYER	TUBE	OIL (SCF)	WATER (SCF)	PORE VOL. (RCF)
1	1	0.13752E+05	0.41670E+05	0.58723E+05
2	1	0.25764E+05	0.26668E+05	0.58717E+05
3	1	0.30780E+05	0.20390E+05	0.58708E+05
4	1	0.32493E+05	0.18234E+05	0.58700E+05
1	2	0.13893E+05	0.41494E+05	0.58723E+05
2	2	0.27491E+05	0.24489E+05	0.58708E+05
3	2	0.31336E+05	0.19669E+05	0.58698E+05
4	2	0.32603E+05	0.18071E+05	0.58691E+05
1	3	0.20160E+05	0.59698E+05	0.84717E+05
2	3	0.40143E+05	0.34700E+05	0.84692E+05
3	3	0.45312E+05	0.28217E+05	0.84679E+05
4	3	0.47043E+05	0.26038E+05	0.84672E+05
1	4	0.20625E+05	0.59965E+05	0.85559E+05
2	4	0.41652E+05	0.33650E+05	0.85528E+05
3	4	0.46307E+05	0.27805E+05	0.85515E+05
4	4	0.47634E+05	0.26131E+05	0.85508E+05
1	5	0.22374E+05	0.64527E+05	0.92279E+05
2	5	0.45039E+05	0.36150E+05	0.92241E+05
3	5	0.49953E+05	0.29975E+05	0.92224E+05
4	5	0.51378E+05	0.28175E+05	0.92216E+05
1	6	0.26588E+05	0.75227E+05	0.10821E+06
2	6	0.54109E+05	0.40771E+05	0.10817E+06
3	6	0.59017E+05	0.34602E+05	0.10815E+06
4	6	0.60354E+05	0.32910E+05	0.10814E+06
1	7	0.34141E+05	0.94354E+05	0.13673E+06
2	7	0.68841E+05	0.50914E+05	0.13667E+06
3	7	0.74690E+05	0.43558E+05	0.13665E+06
4	7	0.76278E+05	0.41552E+05	0.13664E+06
1	8	0.53144E+05	0.12810E+06	0.19415E+06
2	8	0.10167E+06	0.67388E+05	0.19409E+06
3	8	0.10714E+06	0.60503E+05	0.19406E+06
4	8	0.10855E+06	0.58720E+05	0.19405E+06
1	9	0.87867E+05	0.15112E+06	0.26054E+06
2	9	0.13796E+06	0.88435E+05	0.26047E+06
3	9	0.14414E+06	0.80656E+05	0.26045E+06
4	9	0.14574E+06	0.78635E+05	0.26044E+06
1	10	0.58555E+05	0.14647E+06	0.21928E+06
2	10	0.11475E+06	0.76114E+05	0.21919E+06
3	10	0.12135E+06	0.67799E+05	0.21917E+06
4	10	0.12263E+06	0.66186E+05	0.21916E+06
1	11	0.47590E+05	0.13333E+06	0.19246E+06
2	11	0.98837E+05	0.69168E+05	0.19238E+06
3	11	0.10593E+06	0.60251E+05	0.19236E+06
4	11	0.10751E+06	0.58261E+05	0.19235E+06
1	12	0.56136E+05	0.15659E+06	0.22639E+06
2	12	0.11811E+06	0.79005E+05	0.22630E+06
3	12	0.12490E+06	0.70466E+05	0.22628E+06
4	12	0.12645E+06	0.68524E+05	0.22628E+06
TOTALS		0.32287E+07	0.28453E+07	068687E+07
(M-STB)		575.01	506.74	

PERIODIC REPORT ON STATUS OF SIMULATION

```
          YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
          18.0       6566.7    69.123         1                 48

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJ ECTION (STB)
     OIL      WATER     INJECTION            OIL      WATER       INJECTION
     16.10    33.29       50.01            1113.      2301.       3457
(    8.446    26.00       - FROM WELL AT (    1,  1 )  )
(    7.656    7.293       - FROM WELL AT (  65,  1 )  )

     CURRENT IN-PLACE-VOLUMES                           MAXIMUM
OIL (MSTB)         WATER (MSTB)                        PRESSURE
 573.84              507.96                              5491.8

     MATERIAL BALANCE ERROR
  OIL              WATER
0.99989            1.0001
```

PERIODIC REPORT ON STATUS OF SIMULATION

```
          YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
          18.2       6635.8    69.123         2                 49
PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL      WATER     INJECTION            OIL      WATER       INJECTION
     13.66    33.59       50.01            2057.      4623.       6914
(    6.590    25.77       - FROM WELL AT (    1,  1 )  )
(    7.073    7.820       - FROM WELL AT (  65,  1 )  )

     CURRENT IN-PLACE-VOLUMES                           MAXIMUM
OIL (MSTB)         WATER (MSTB)                        PRESSURE
 572.90              509.09                              5569.9

     MATERIAL BALANCE ERROR
  OIL              WATER
0.99990            1.0001
```

PERIODIC REPORT ON STATUS OF SIMULATION

```
          YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
          24.6       8986.0    69.123         36                83

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL      WATER     INJECTION            OIL      WATER       INJECTION
     7.892    40.20       50.01            0.2570E+05  0.9268E+05  0.1244E+06
(    4.677    27.64       - FROM WELL AT (    1,  1 )  )
(    3.215    12.56       - FROM WELL AT (  65,  1 )  )

     CURRENT IN-PLACE-VOLUMES                           MAXIMUM
OIL (MSTB)         WATER (MSTB)                        PRESSURE
 549.10              538.78                              5588.3

     MATERIAL B ALANCE ERROR
  OIL              WATER
0.99963            1.0006
```

PERIODIC REPORT ON STATUS OF SIMULATION

```
          YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
          31.2       11405.3   69.123         71                118

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL      WATER     INJECTION            OIL      WATER       INJECTION
     6.685    41.66       50.01            0.4326E+05  0.1918E+06  0.2454E+06
(    3.971    28.51       - FROM WELL AT (    1,  1 )  )
```

```
(     2.715    13.16        - FROM WELL AT (   65,  1 )  )

     CURRENT IN-PLACE-VOLUMES                              MAXIMUM
OIL (MSTB)        WATER (MSTB)                           PRESSURE
 531.37             560.97                                 5671.4

     MATERIAL BALANCE ERROR
  OIL              WATER
0.99932            1.0012
```

PERIODIC REPORT ON STATUS OF SIMULATION

```
           YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
           38.0       13893.7   69.123        107               154

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL      WATER     INJECTION            OIL      WATER       INJECTION
     5.927    42.61       50.01            0.5882E+05 0.2968E+06 0.3699E+06
(    3.428    29.18       - FROM WELL AT (    1,  1 )  )
(    2.499    13.43       - FROM WELL AT (  65,  1 )  )

     CURRENT IN-PLACE-VOLUMES                              MAXIMUM
OIL (MSTB)        WATER (MSTB)                           PRESSURE
 515.66             580.64                                 5601.4

     MATERIAL BALANCE ERROR
  OIL              WATER
0.99905            1.0016
```

PERIODIC REPORT ON STATUS OF SIMULATION

```
           YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
           44.7       16313     69.123        142               189

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL      WATER     INJECTION            OIL      WATER       INJECTION
     5.272    43.43       50.01            0.7239E+050.4008e+06   0.4909E+06
(    2.917    29.83       - FROM WELL AT (    1,  1 )  )
(    2.355    13.60       - FROM WELL AT (  65,  1 )  )

     CURRENT IN-PLACE-VOLUMES                              MAXIMUM
OIL (MSTB)        WATER (MSTB)                           PRESSURE
 501.97             597.80                                 5561.3

     MATERIAL BALANCE ERROR
  OIL              WATER
0.99884            1.0020


**************************

TIME STEPS EXECUTED        160
GRID-CELL-TIME-STEPS    460800
```

PERFORMANCE VERSUS TIME FOR NON-INFILL

TIME DAYS	OIL RATE STB/D	WATER RATE STB/D	CUMOIL MSTB	WCUT FRAC.	PV INJ FRAC.	OIL REC % OOIP
138.25	15.15	0.9468E-11	2.095	0.000	0.00	0.3
276.49	17.91	0.4871E-05	4.570	0.000	0.01	0.7
414.74	18.77	0.1074E-04	7.165	0.000	0.01	1.0
552.98	19.21	0.1169E-04	9.821	0.000	0.01	1.4
691.23	19.36	0.3668E-04	12.50	0.000	0.01	1.8
829.47	19.51	0.3241E-04	15.19	0.000	0.02	2.2
967.72	19.59	0.3397E-04	17.90	0.000	0.02	2.6
1105.97	19.67	0.3488E-04	20.62	0.000	0.02	3.0
1244.21	19.69	0.4979E-04	23.34	0.000	0.03	3.4
1382.46	19.74	0.5537E-04	26.07	0.000	0.03	3.8
1520.70	19.77	0.6221E-04	28.80	0.000	0.03	4.2
1658.95	19.81	0.5681E-04	31.54	0.000	0.03	4.6
1797.19	19.80	0.5364E-04	34.28	0.000	0.04	5.0
1935.44	19.78	0.6552E-04	37.01	0.000	0.04	5.4
2073.69	19.82	0.7129E-04	39.75	0.000	0.04	5.8
2211.93	19.81	0.6811E-04	42.49	0.000	0.05	6.2
2350.18	19.85	0.1007E-04	45.24	0.000	0.05	6.6
2488.42	19.84	0.8793E-04	47.98	0.000	0.05	7.0
2626.67	19.83	0.9590E-04	50.72	0.000	0.05	7.4
2764.91	19.84	0.9537E-04	53.46	0.000	0.06	7.8
2903.16	19.85	0.8521E-04	56.21	0.000	0.06	8.2
3041.41	19.88	0.7757E-04	58.96	0.000	0.06	8.6
3179.65	19.85	0.6805E-04	61.70	0.000	0.07	9.0
3317.90	19.83	0.6939E-04	64.44	0.000	0.07	9.4
3456.14	19.79	0.8674E-04	67.18	0.000	0.07	9.8
3594.39	19.81	0.9700E-04	69.92	0.000	0.07	10.2
3732.63	19.74	0.9506E-04	72.65	0.000	0.08	10.6
3870.88	19.67	0.1359E-03	75.37	0.000	0.08	11.0
4009.12	19.57	0.4731E-01	78.07	0.002	0.08	11.4
4147.37	19.13	0.7110	80.72	0.036	0.08	11.8
4285.62	17.84	2.356	83.18	0.117	0.09	12.2
4423.86	16.61	3.837	85.48	0.188	0.09	12.5
4562.11	16.25	4.280	87.73	0.208	0.09	12.8
4700.35	15.65	4.945	89.89	0.240	0.10	13.1
4838.60	15.10	5.741	91.98	0.276	0.10	13.4
4976.84	14.15	7.058	93.93	0.333	0.10	13.7
5115.09	12.63	98.03	95.68	0.418	0.10	14.0
5253.33	11.60	10.39	97.28	0.472	0.11	14.2
5391.58	10.91	11.27	98.79	0.508	0.11	14.4
5529.83	10.58	11.65	100.3	0.524	0.11	14.7
5668.07	10.39	11.87	101.7	0.533	0.12	14.9
5806.32	10.25	12.00	103.1	0.539	0.12	15.1
5944.56	10.17	12.16	104.5	0.545	0.12	15.3
6082.81	9.950	12.43	105.9	0.555	0.12	15.5
6221.05	9.531	12.95	107.2	0.576	0.13	15.7
6359.30	9.159	13.38	108.5	0.594	0.13	15.9
6497.55	8.949	13.61	109.7	0.603	0.13	16.0
6635.79	8.778	13.74	110.9	0.610	0.14	16.2
6774.04	8.681	13.86	112.1	0.615	0.14	16.4
6912.28	8.586	13.98	113.3	0.619	0.14	16.6
7050.53	8.436	14.22	114.5	0.628	0.14	16.7
7188.77	8.097	14.71	115.6	0.645	0.15	16.9
7327.02	7.619	15.30	116.6	0.668	0.15	17.0
7465.26	7.189	15.83	117.6	0.688	0.15	17.2
7603.51	6.832	16.31	118.6	0.705	0.16	17.3
7741.76	6.573	16.67	119.5	0.717	0.16	17.5
7880.00	6.395	16.96	120.4	0.726	0.16	17.6
8018.25	6.065	17.43	121.2	0.742	0.16	17.7
8156.49	5.643	17.96	122.0	0.761	0.17	17.8
8294.74	5.347	18.36	122.7	0.774	0.17	17.9
8432.98	5.177	18.58	123.5	0.782	0.17	18.0

8571.23	5.067	18.74	124.2	0.787	0.18	18.1
8709.48	4.965	18.86	124.8	0.792	0.18	18.2
8847.72	4.914	18.94	125.5	0.794	0.18	18.3
8985.97	4.828	19.03	126.2	0.798	0.18	18.4
9124.21	4.787	19.09	126.8	0.799	0.19	18.5
9262.46	4.728	19.15	127.5	0.802	0.19	18.6
9400.71	4.694	19.20	128.1	0.804	0.19	18.7
9538.95	4.646	19.25	128.8	0.806	0.20	18.8
9677.20	4.613	19.29	129.4	0.807	0.20	18.9
9815.45	4.573	19.33	130.1	0.809	0.20	19.0
9953.69	4.545	19.37	130.7	0.810	0.20	19.1
10091.94	4.521	19.41	131.3	0.811	0.21	19.2
10230.18	4.482	19.44	131.9	0.813	0.21	19.3
10368.43	4.470	19.46	132.6	0.813	0.21	19.4
10506.68	4.428	19.50	133.2	0.815	0.21	19.5
10644.92	4.411	19.52	133.8	0.816	0.22	19.6
10783.17	4.388	19.55	134.4	0.817	0.22	19.6
10921.41	4.365	19.58	135.0	0.818	0.22	19.7
11059.66	4.337	19.60	135.6	0.819	0.23	19.8
11197.91	4.318	19.63	136.2	0.820	0.23	19.9
11336.15	4.305	19.65	136.8	0.820	0.23	20.0
11474.40	4.287	19.68	137.4	0.821	0.23	20.1
11612.64	4.277	19.70	138.0	0.822	0.24	20.2
11750.89	4.244	19.72	138.5	0.823	0.24	20.2
11889.14	4.231	19.74	139.1	0.823	0.24	20.3
12027.38	4.225	19.76	139.7	0.824	0.25	20.4
12165.63	4.204	19.78	140.3	0.825	0.25	20.5
12303.88	4.194	19.79	140.9	0.825	0.25	20.6
12442.12	4.174	19.82	141.5	0.826	0.25	20.7
12580.37	4.162	19.83	142.0	0.827	0.26	20.8
12718.61	4.151	19.85	142.6	0.827	0.26	20.8
12856.86	4.134	19.87	143.2	0.828	0.26	20.9
12995.11	4.109	19.89	143.7	0.829	0.27	21.0
13133.35	4.091	19.90	144.3	0.830	0.27	21.1
13271.60	4.079	19.93	144.9	0.830	0.27	21.2
13409.84	4.072	19.93	145.4	0.830	0.27	21.3
13548.09	4.074	19.95	146.0	0.830	0.28	21.3
13686.34	4.051	19.97	146.6	0.831	0.28	21.4
13824.58	4.042	19.98	147.1	0.832	0.28	21.5
13962.83	4.032	19.99	147.7	0.832	0.29	21.6
14101.07	4.010	20.01	148.2	0.833	0.29	21.7
14239.32	4.008	20.02	148.8	0.833	0.29	21.7
14377.57	3.984	20.04	149.3	0.834	0.29	21.8
14515.81	3.970	20.05	149.9	0.835	0.30	21.9
14654.06	3.968	20.06	150.4	0.835	0.30	22.0
14792.30	3.952	20.07	151.0	0.835	0.30	21.1
14930.55	3.942	20.09	151.5	0.836	0.31	21.1
15068.80	3.930	20.11	152.1	0.836	0.31	22.2
15207.04	3.922	20.11	152.6	0.837	0.31	22.3
15345.29	3.918	20.13	153.2	0.837	0.31	22.4
15483.54	3.907	20.14	153.7	0.838	0.32	22.5
15621.78	3.887	20.16	154.2	0.838	0.32	22.5
15760.03	3.882	20.17	154.8	0.839	0.32	22.6
15898.27	3.878	20.18	155.3	0.839	0.33	22.7
16036.52	3.861	20.19	155.8	0.839	0.33	22.8
16174.77	3.860	20.20	156.4	0.840	0.33	22.9
16313.01	3.837	20.22	156.9	0.841	0.33	22.9
16451.26	3.833	20.22	157.4	0.841	0.34	23.0
16589.50	3.805	20.24	158.0	0.842	0.34	23.1
16727.75	3.818	20.24	158.5	0.841	0.34	23.2
16866.00	3.786	20.27	159.0	0.843	0.35	23.2
17004.24	3.796	20.27	159.5	0.842	0.35	23.3
17142.49	3.783	20.28	160.1	0.843	0.35	23.4
17280.73	3.756	20.29	160.6	0.844	0.35	23.5
17418.98	3.764	20.30	161.1	0.844	0.36	23.5
17557.23	3.747	20.32	161.6	0.844	0.36	23.6
17695.47	3.752	20.33	162.1	0.844	0.36	23.7

17833.72	3.740	20.34	162.6	0.845	0.36	23.8
17971.96	3.729	20.35	163.2	0.845	0.37	23.8
18110.21	3.710	20.37	163.7	0.846	0.37	23.9
18248.46	3.720	20.37	164.2	0.846	0.37	24.0
18386.70	3.694	20.38	164.7	0.847	0.38	24.1
18524.95	3.692	20.39	165.2	0.847	0.38	24.1
18663.20	3.673	20.41	165.7	0.847	0.38	24.2
18801.44	3.676	20.41	166.2	0.847	0.38	24.3
18939.69	3.662	20.43	166.7	0.848	0.39	24.4
19077.93	3.654	20.44	167.2	0.848	0.39	24.4
19216.18	3.647	20.45	167.7	0.849	0.39	24.5
19354.43	3.643	20.45	168.2	0.849	0.40	24.6
19492.67	3.629	20.48	168.7	0.849	0.40	24.7
19630.92	3.619	20.48	169.2	0.850	0.40	24.7
19769.16	3.614	20.49	169.7	0.850	0.40	24.8
19907.41	3.604	20.50	170.2	0.850	0.41	24.9
20045.66	3.588	20.51	170.7	0.851	0.41	25.0
20183.90	3.589	20.52	171.2	0.851	0.41	25.0
20322.15	3.577	20.53	171.7	0.852	0.42	25.1
20460.39	3.578	20.54	172.2	0.852	0.42	25.2
20598.64	3.557	20.56	172.7	0.852	0.42	25.2
20736.89	3.547	20.57	173.2	0.853	0.42	25.3
20875.13	3.545	20.58	173.7	0.853	0.43	25.4
21013.38	3.521	20.59	174.2	0.854	0.43	25.5
21151.63	3.522	20.60	174.7	0.854	0.43	25.5
21289.87	3.511	20.61	175.2	0.854	0.44	25.6
21428.12	3.507	20.62	175.6	0.855	0.44	25.7
21566.36	3.497	20.64	176.1	0.855	0.44	25.7
21704.61	3.485	20.64	176.6	0.856	0.44	25.8
21842.86	3.475	20.66	177.1	0.856	0.45	25.9
21981.10	3.480	20.66	177.6	0.856	0.45	26.0
22119.35	3.446	20.69	178.0	0.857	0.45	26.0
22257.59	3.439	20.69	178.5	0.857	0.46	26.1
22395.84	3.437	20.71	179.0	0.858	0.46	26.2
22534.09	3.430	20.72	179.5	0.858	0.46	26.2
22672.33	3.410	20.73	179.9	0.859	0.46	26.3
22810.58	3.407	20.74	180.4	0.859	0.47	26.4
22948.82	3.398	20.75	180.9	0.859	0.47	26.4
23087.07	3.388	20.77	181.4	0.860	0.47	26.5
23225.32	3.373	20.78	181.8	0.860	0.48	26.6
23363.56	3.374	20.79	182.3	0.860	0.48	26.6
23501.81	3.364	20.81	182.7	0.861	0.48	26.7
23640.05	3.336	20.82	183.2	0.862	0.48	26.8
23778.30	3.346	20.83	183.7	0.862	0.49	26.8
23916.55	3.318	20.85	184.1	0.863	0.49	26.9
24054.79	3.324	20.85	184.6	0.863	0.49	27.0
24193.04	3.301	20.88	185.0	0.863	0.49	27.0
24331.29	3.305	20.88	185.5	0.863	0.50	27.1
24469.53	3.287	20.90	186.0	0.864	0.50	27.2
24607.78	3.285	20.91	186.4	0.864	0.50	27.2
24746.02	3.259	20.93	186.9	0.865	0.51	27.3
24884.27	3.250	20.93	187.3	0.866	0.51	27.4
25022.52	3.245	20.96	187.8	0.866	0.51	27.4
25160.76	3.232	20.96	188.2	0.866	0.51	27.5
25299.01	3.213	20.97	188.7	0.867	0.52	27.6
25437.25	3.206	20.98	189.1	0.867	0.52	27.6
25575.50	3.199	21.01	189.5	0.868	0.52	27.7
25713.75	3.182	21.02	190.0	0.869	0.53	27.8
25851.99	3.169	21.04	190.4	0.869	0.53	27.8
25990.24	3.170	21.05	190.9	0.869	0.53	27.9
26128.48	3.154	21.07	191.3	0.870	0.53	28.0
26266.72	3.136	21.08	191.7	0.870	0.54	28.0
26404.98	3.130	21.09	192.2	0.871	0.54	28.1
26543.22	3.108	21.11	192.6	0.872	0.54	28.1
26681.47	3.090	21.14	193.0	0.872	0.55	28.2
26819.71	3.079	21.15	193.4	0.873	0.55	28.3
26957.96	3.059	21.17	193.9	0.874	0.55	28.3

27096.21	3.042	21.20	194.3	0.874	0.55	28.4
27234.45	3.029	21.21	194.7	0.875	0.56	28.5
27372.70	3.013	21.24	195.1	0.876	0.56	28.5
27510.95	3.002	21.25	195.5	0.876	0.56	28.6
27649.19	2.977	21.28	195.9	0.877	0.57	28.6
27787.44	2.966	21.30	196.4	0.878	0.57	28.7
27925.68	2.946	21.32	196.8	0.879	0.57	28.8
28063.93	2.927	21.35	197.2	0.879	0.57	28.8
28202.18	2.904	21.36	197.6	0.880	0.58	28.9
28340.42	2.882	21.39	198.0	0.881	0.58	28.9
28478.67	2.880	21.41	198.4	0.881	0.58	29.0
28616.91	2.866	21.43	198.8	0.882	0.59	29.0
28755.16	2.844	21.45	199.2	0.883	0.59	29.1
28893.41	2.830	21.48	199.5	0.884	0.59	29.2
29031.65	2.811	21.49	199.9	0.884	0.59	29.2
29169.90	2.792	21.52	200.3	0.885	0.60	29.3
29308.14	2.779	21.53	200.7	0.886	0.60	29.3
29446.39	2.758	21.55	201.1	0.887	0.60	29.4
29584.64	2.753	21.57	201.5	0.887	0.61	29.4
29722.88	2.735	21.59	201.8	0.888	0.61	29.5
29861.13	2.718	21.61	202.2	0.888	0.61	29.6
29999.38	2.710	21.63	202.6	0.889	0.61	29.6
30137.62	2.681	21.65	203.0	0.890	0.62	29.7
30275.87	2.682	21.66	203.3	0.890	0.62	29.7
30414.11	2.667	21.68	203.7	0.890	0.62	29.8
30552.36	2.641	21.70	204.1	0.892	0.63	29.8
30690.61	2.643	21.72	204.4	0.892	0.63	29.9
30828.85	2.620	21.74	204.8	0.892	0.63	29.9
30967.10	2.610	21.76	205.2	0.893	0.63	30.0
31105.34	2.598	21.78	205.5	0.893	0.64	30.0
31243.59	2.569	21.79	205.9	0.895	0.64	30.1
31381.84	2.571	21.81	206.2	0.895	0.64	30.1
31520.08	2.531	21.83	206.6	0.896	0.64	30.2
31658.33	2.532	21.85	206.9	0.896	0.65	30.2
31796.57	2.518	21.87	207.3	0.897	0.65	30.3
31934.82	2.493	21.90	207.6	0.898	0.65	30.3
32073.07	2.481	21.90	208.0	0.898	0.66	30.4
32211.31	2.472	21.94	208.3	0.899	0.66	30.4
32349.56	2.443	21.94	208.6	0.900	0.66	30.5
32487.80	2.426	21.98	209.0	0.901	0.66	30.5

PERFORMANCE VERSUS TIME FOR INFILL

TIME DAYS	OIL RATE STB/D	WATER RATE STB/D	CUMOIL MSTB	WCUT FRAC.	PV INJ FRAC.	OIL REC % OOIP
6497.55	3.299	25.29	109.7	0.885	0.13	
6566.67	16.10	33.29	110.8	0.674	0.14	16.2
6635.79	13.66	33.59	111.8	0.711	0.14	16.3
6704.91	13.13	33.89	112.7	0.721	0.14	16.5
6774.04	12.80	34.16	113.6	0.727	0.14	16.6
6843.16	12.65	34.28	114.4	0.731	0.15	16.7
6912.28	12.44	34.51	115.3	0.735	0.15	16.8
6981.41	12.24	34.72	116.1	0.739	0.15	17.0
7050.53	12.05	34.93	117.0	0.743	1.16	17.1
7119.65	12.00	35.01	117.8	0.745	0.16	17.2
7188.78	11.85	35.16	118.6	0.748	0.16	17.3
7257.90	11.75	35.28	119.4	0.750	0.16	17.5
7327.02	11.59	35.45	120.2	0.754	0.17	17.6
7396.15	11.46	35.60	121.0	0.756	0.17	17.7
7465.27	11.31	35.78	121.8	0.760	0.17	17.8
7534.39	11.17	35.99	122.6	0.763	0.18	17.9
7603.51	10.95	36.30	123.3	0.768	0.18	18.0
7672.64	10.63	36.73	124.1	0.776	0.18	18.1
7741.76	10.23	37.25	124.8	0.785	0.18	18.2
7810.88	9.804	37.77	125.5	0.794	0.19	18.3

7880.01	9.467	38.21	126.1	0.801	0.19	18.4
7949.13	9.206	38.55	126.7	0.807	0.19	18.5
8018.25	9.029	38.77	127.4	0.811	0.20	18.6
8087.38	8.872	38.96	128.0	0.815	0.20	18.7
8156.50	8.732	39.14	128.6	0.818	0.20	18.8
8225.62	8.630	39.27	129.2	0.820	0.20	18.9
8294.74	8.564	39.37	129.8	0.821	0.21	19.0
8363.87	8.480	39.49	130.4	0.823	0.21	19.1
8432.99	8.361	39.61	130.9	0.826	0.21	19.1
8502.11	8.299	39.68	131.5	0.827	0.21	19.2
8571.24	8.221	39.79	132.1	0.829	0.22	19.3
8640.36	8.146	39.88	132.6	0.830	0.22	19.4
8709.48	8.091	39.93	133.2	0.832	0.22	19.5
8778.61	8.045	40.01	133.8	0.833	0.23	19.5
8847.73	7.989	40.09	134.3	0.834	0.23	19.6
8916.85	7.941	40.13	134.9	0.835	0.23	19.7
8985.97	7.892	40.20	135.4	0.836	0.23	19.8
9055.10	7.833	40.26	135.9	0.837	0.24	19.9
9124.22	7.793	40.32	136.5	0.838	0.24	19.9
9193.34	7.767	40.36	137.0	0.839	0.24	20.0
9262.47	7.723	40.41	137.6	0.840	0.25	20.1
9331.59	7.667	40.46	138.1	0.841	0.25	20.2
9400.71	7.628	40.51	138.6	0.842	0.25	20.3
9469.84	7.599	40.57	139.1	0.842	0.25	20.3
9538.96	7.575	40.58	139.7	0.843	0.26	20.4
9608.08	7.514	40.64	140.2	0.844	0.26	20.5
9677.21	7.487	40.69	140.7	0.845	0.26	20.6
9746.33	7.457	40.71	141.2	0.845	0.27	20.6
9815.45	7.426	40.75	141.7	0.846	0.27	20.7
9884.57	7.388	40.80	142.2	0.847	0.27	20.8
9953.70	7.369	40.83	142.7	0.847	0.27	20.9
10022.82	7.329	40.87	143.3	0.848	0.28	20.9
10091.94	7.318	40.89	143.8	0.848	0.28	21.0
10161.07	7.282	40.92	144.3	0.849	0.28	21.1
10230.19	7.249	40.95	144.8	0.850	0.29	21.2
10299.31	7.220	40.99	145.3	0.850	0.29	21.2
10368.44	7.211	41.00	145.8	0.850	0.29	21.3
10437.56	7.173	41.05	146.3	0.851	0.29	21.4
10506.68	7.157	41.07	146.8	0.852	0.30	21.4
10575.80	7.094	41.14	147.2	0.853	0.30	21.5
10644.93	7.106	41.14	147.7	0.853	0.30	21.6
10714.05	7.063	41.20	148.2	0.854	0.31	21.7
10783.17	7.024	41.25	148.7	0.854	0.31	21.7
10852.30	7.000	41.27	149.2	0.855	0.31	21.8
10921.42	6.982	41.31	149.7	0.855	0.31	21.9
10990.54	6.922	41.37	150.2	0.857	0.32	21.9
11059.67	6.885	41.42	150.6	0.857	0.32	22.0
11128.79	6.841	41.49	151.1	0.858	0.32	22.1
11197.91	6.792	41.53	151.6	0.859	0.33	22.2
11267.04	6.771	41.57	152.0	0.860	0.33	22.2
11336.16	6.720	41.62	152.5	0.861	0.33	22.3
11405.28	6.685	41.66	153.0	0.862	0.33	22.4
11474.40	6.644	41.71	153.4	0.863	0.34	22.4
11543.53	6.625	41.75	153.9	0.863	0.34	22.5
11612.65	6.579	41.77	154.3	0.864	0.34	22.6
11681.77	6.580	41.80	154.8	0.864	0.34	22.6
11750.90	6.584	41.80	155.2	0.864	0.35	22.7
11820.02	6.545	41.82	155.7	0.865	0.35	22.8
11889.14	6.523	41.86	156.2	0.865	0.35	22.8
11958.27	6.495	41.89	156.6	0.866	0.36	22.9
12027.39	6.452	41.93	157.0	0.867	0.36	23.0
12096.51	6.458	41.93	157.5	0.867	0.36	23.0
12165.63	6.441	41.96	157.9	0.867	0.36	23.1
12234.76	6.429	41.98	158.4	0.867	0.37	23.1
12303.88	6.395	42.02	158.8	0.868	0.37	23.2
12373.00	6.373	42.04	159.3	0.868	0.37	23.3
12442.13	6.339	42.08	159.7	0.869	0.38	23.3

12511.25	6.334	42.11	160.1	0.869	0.38	23.4
12580.37	6.269	42.16	160.6	0.871	0.38	23.5
12649.50	6.263	42.19	161.0	0.871	0.38	23.5
12718.62	6.231	42.23	161.4	0.871	0.39	23.6
12787.74	6.196	42.26	161.9	0.872	0.39	23.7
12856.87	6.192	42.28	162.3	0.872	0.39	23.7
12925.99	6.148	42.33	162.7	0.873	0.40	23.8
12995.11	6.122	42.37	163.1	0.874	0.40	23.8
13064.23	6.109	42.38	163.6	0.874	0.40	23.9
13133.36	6.081	42.43	164.0	0.875	0.40	24.0
13202.48	6.030	42.47	164.4	0.876	0.41	24.0
13271.60	6.024	42.49	164.8	0.876	0.41	24.1
13340.73	6.010	42.51	165.2	0.876	0.41	24.1
13409.85	5.980	42.54	165.6	0.877	0.42	24.2
13478.97	5.961	42.56	166.1	0.877	0.42	24.3
13548.10	5.954	42.57	166.5	0.877	0.42	24.3
13617.22	5.972	42.54	166.9	0.877	0.42	24.4
13686.34	5.936	42.58	167.3	0.878	0.43	24.4
13755.46	5.931	42.60	167.7	0.878	0.43	24.5
13824.59	5.935	42.61	168.1	0.878	0.43	24.6
13893.71	5.927	42.61	168.5	0.878	0.44	24.6
13962.83	5.882	42.66	168.9	0.879	0.44	24.7
14031.96	5.852	42.68	169.3	0.879	0.44	24.7
14101.08	5.829	42.71	169.7	0.880	0.44	24.8
14170.20	5.834	42.73	170.1	0.880	0.45	24.9
14239.33	5.824	42.72	170.5	0.880	0.45	24.9
14308.45	5.809	42.75	170.9	0.880	0.45	25.0
14377.57	5.780	42.77	171.3	0.881	0.46	25.0
14446.70	5.791	42.78	171.7	0.881	0.46	25.1
14515.82	5.751	42.81	172.1	0.882	0.46	25.2
14584.94	5.745	42.82	172.5	0.882	0.46	25.2
14654.06	5.741	42.83	172.9	0.882	0.47	25.3
14723.19	5.730	42.83	173.3	0.882	0.47	25.3
14792.31	5.717	42.87	173.7	0.882	0.47	25.4
14861.43	5.694	42.89	174.1	0.883	0.47	25.4
14930.56	5.684	42.90	174.5	0.883	0.48	25.5
14999.68	5.664	42.94	174.9	0.883	0.48	25.6
15068.80	5.659	42.93	175.3	0.884	0.48	25.6
15137.93	5.622	42.97	175.7	0.884	0.49	25.7
15207.05	5.610	43.00	176.1	0.885	0.49	25.7
15276.17	5.593	43.02	176.5	0.885	0.49	25.8
15345.29	5.575	43.05	176.8	0.885	0.49	25.8
15414.42	5.545	43.07	177.2	0.886	0.50	25.9
15483.54	5.559	43.07	177.6	0.886	0.50	26.0
15552.66	5.540	43.09	178.0	0.886	0.50	26.0
15621.79	5.533	43.10	178.4	0.886	0.51	26.1
15690.91	5.487	43.16	178.8	0.887	0.51	26.1
15760.03	5.457	43.20	179.1	0.888	0.51	26.2
15829.16	5.442	43.22	179.5	0.888	0.51	26.2
15898.28	5.407	43.26	179.9	0.889	0.52	26.3
15967.40	5.401	43.28	180.3	0.889	0.52	26.3
16036.53	5.359	43.31	180.6	0.890	0.52	26.4
16105.65	5.358	43.34	181.0	0.890	0.53	26.5
16174.77	5.320	43.36	181.4	0.891	0.53	26.5
16243.89	5.301	43.40	181.7	0.891	0.53	26.6
16313.02	5.272	43.43	182.1	0.892	0.53	26.6
16382.14	5.255	43.45	182.5	0.892	0.54	26.7
16451.26	5.227	43.48	182.8	0.893	0.54	26.7
16520.39	5.228	43.51	183.2	0.893	0.54	26.8
16589.51	5.171	43.55	183.5	0.894	0.55	26.8
16658.63	5.169	43.56	183.9	0.894	0.55	26.9
16727.76	5.132	43.60	184.3	0.895	0.55	26.9
16796.88	5.132	43.62	184.6	0.895	0.55	27.0
16866.00	5.078	43.67	185.0	0.896	0.56	27.0
16935.13	5.092	43.67	185.3	0.896	0.56	27.1
17004.25	5.023	43.72	185.7	0.897	0.56	27.1
17073.37	5.030	43.73	186.0	0.897	0.57	27.2

17142.49	4.991	43.78	186.4	0.898	0.57	27.2
17211.62	4.977	43.80	186.7	0.898	0.57	27.3
17280.74	4.937	43.84	187.0	0.899	0.57	27.3
17349.86	4.936	43.85	187.4	0.899	0.58	27.4
17418.99	4.897	43.89	187.7	0.900	0.58	27.4
17488.11	4.888	43.91	188.1	0.900	0.58	27.5
17557.23	4.856	43.93	188.4	0.900	0.59	27.5

TOTAL PATTERN RESULTS:

WATERFLOOD RECOVERY	:	1671.82	MSTB
WATERFLOOD+INFILL RECOVERY	:	1507.11	MSTB
INCREMENTAL OIL FROM INFILL	:	-164.72	MSTB
INCREMENTAL OIL FROM INFILL	:	-3.01	% OOIP
ORIGINAL OIL IN PLACE	:	5474.04	MSTB

APPENDIX 1b
SimBest II INPUT/OUTPUT FOR IDPM VERIFICATION AGAINST BLACK-OIL SIMULATION

```
*C                                S I M E A S E
*C                             R E L E A S E    2.1.17
*C                       INITIALIZATION DECK FOR SIMBEST II
*C
*C
*C                    PROJECT:  IDPM/SimBest II Comparison
*C                    CASE:
*C                    DATE:    23-JAN-92
*C                    TIME:    15:17:28
*C
*C
*TITLE     Comparing IDPM to SimBest
*C
*C
*C
*C *PROJECT        Comparison
*C *CASE
*C
*C
*C ------ START OF BASIC DATA
*C
*LIST
*C
*WO
*C
*GRID     *XYZ        5       5     4
*C
*C             DWSTD            CW       BWINIT         VISW       TRSTD
*MISC         .99955       3.00000E-06   1.0010       .60000      117.00
*C
*STDCON       14.650        60.000
*C
*IDATE        01 01 70
*C
*C
*OUTPUT   *TABLES   *ARRAYS
*C
*C
*WINIT    *SKIP
*C
*C
*CRVAR    *MATRIX   *CONSTANT   3.00000E-06
*C
*C
*C ------ END OF BASIC DATA
*C
*C
*C
*C ------ START OF TABULAR DATA
*C
*C
*SATWO    1

*C    SW          KRW          KRO
     0.300      0.0000       0.8000
     0.323      0.0006       0.7180
     0.346      0.0022       0.6404
     0.369      0.0050       0.5673
```

```
     0.392      0.0089       0.4986
     0.415      0.0139       0.4343
     0.438      0.0199       0.3745
     0.461      0.0271       0.3191
     0.484      0.0355       0.2681
     0.530      0.0554       0.1795
     0.553      0.0670       0.1418
     0.576      0.0798       0.1086
     0.599      0.0936       0.0798
     0.622      0.1086       0.0554
     0.645      0.1247       0.0355
     0.668      0.1418       0.0199
     0.691      0.1601       0.0089
     0.714      0.1795       0.0022
     0.737      0.2000       0.0000
     0.760      0.2216       0.0000
     1.000      0.2220       0.0000
*C
*PVTO    1    2220.58
*API  32.0          *CO  7.35E-6      *VCO   4. OE-4  *BP  2220.58
*C   BPT            RST       VOT           BOT
    14.70        0.3718    9.0708       1.0189
   382.35       86.8951    6.1412       1.0478
   749.99      178.4503    4.4122       1.0862
  1117.64      271.5872    3.5390       1.1291
  1485.29      374.2831    2.8510       1.1787
  1852.94      446.1792    2.4834       1.2144
  2220.58      534.8992    2.1270       1.2591
  2588.23      670.6199    1.7270       1.3286
  2955.88      839.9977    1.3821       1.4166
  3323.53     1033.1050    1.1101       1.5185
  3691.17     1260.2634    0.8847       1.6400
  4058.82     1535.5167    0.6902       1.7899
  4426.47     1879.7977    0.5162       1.9815
  4794.12     2326.6694    0.3559       2.2372
  5161.76     2934.2632    0.2042       2.5987
  5529.41     3813.4346    0.0590       3.1517
  5897.06     5205.7295    0.0100       4.1048
*C
*C
                             *PVTG    *BG   1    .8
*C   BPT            BGT       VGT
    14.70      197.1380    0.0107
   382.35        6.7240    0.0112
   749.99        3.0475    0.0121
  1117.64        1.8684    0.0137
```

```
  1485.29        1.3231    0.0159
  1852.94        1.0276    0.0187
  2220.58         .8530    0.0220
  2588.23         .7439    0.0254
  2955.88         .6731    0.0289
  3323.53         .6256    0.0320
  3691.17         .5926    0.0348
  4058.82         .5690    0.0372
  4426.47         .5512    0.0393
  4794.12         .5373    0.0412
  5161.76         .5257    0.0429
  5529.41         .5158    0.0445
  5897.06         .5068    0.0461
*C ------ END OF TABULAR DATA
*C
*C
*C ------ START OF GRID DATA
*C
*C
*C
*DXH      *XVAR
   233.35    233.35    233.35    233.35    233.35
*C
*DYH      *YVAR
   233.35    233.35    233.35    233.35    233.35
*C
*TH    *CON
    62.5
*THNET    *CON
    62.5
*C
*HTOP  *LAYER
    6500  6500  6500  6500  6500
    6500  6500  6500  6500  6500
    6500  6500  6500  6500  6500
                            6500  6500  6500  6500  6500
                            6500  6500  6500  6500  6500
*C
*KX *ZVAR
    2.25    .25    .08    .02
*KY *ZVAR
    2.25    .25    .08    .02
*KZ *MULT
    0.01*KX
*PHI  *CON
    0.063
*OVER *PV
        1    1    1    1    1    4   *MULTIPLY   .125000
        2    5    1    1    1    4   *SETEQUAL   .000000
        2    2    2    2    1    4   *MULTIPLY   .500000
        3    5    2    2    1    4   *SETEQUAL   .000000
        3    3    3    3    1    4   *MULTIPLY   .500000
        4    5    3    3    1    4   *SETEQUAL   .000000
        4    4    4    4    1    4   *MULTIPLY   .500000
        5    5    4    4    1    4   *SETEQUAL   .000000
        1    1    5    5    1    4   *MULTIPLY   .250000
        5    5    5    5    1    4   *MULTIPLY   .125000
        2    4    5    5    1    4   *MULTIPLY   .500000
        1    1    2    4    1    4   *MULTIPLY   .500000
*C
*C ------ END OF GRID DATA
*C
*C
```

```
*C ------ NO AQUIFER DATA
*C
*C
*C
                          *C ------START OF EQUIL DATA
                                       *C
                                       *C
                                    *EQUIL
                                       *C
                         *C                          INITIAL
     *C    REGION   DATUM   PRESSURE     WOC     PCWOC      GOC     PCGOC
                                    BPINI
                                       *C
            1   6500.00   3000.00   7000.00      .00      0.00       .00
                                   2220.58
                                       *C
                          *C ------ END OF EQUIL DATA
                                       *C
                                   *ENDJOB
                                  *C *CASE
*C
*C      S I M E A S E
*C                            R E L E A S E  2.1.17
*C      RUN DECK FOR SIMBEST II
*C
*C                           PROJECT:  IDPM/SimBest II Comparison
*C
*C                           CASE:
*C
*C                           DATE:       23-JAN-92
*C
*C                           TIME:       15:22:24
*C
*C
*C
*C
*RTITLE  Comparison
*C
*C
*C
*C *PROJECT         Comparison
*C *CASE
*C
*C
*WELL    1    *PROD     *MULT  1
*WELL    2    *INJ1     *MULT  1
*WELL    3    *PROD2    *MULT  1
*PROD    *O  1
*INJ     *W  2
*PROD    *O  3
*PERF    1   *IJK  4  5 5 1  5 5 2  5 5 3  5 5 4   17.58     1.95   0.625  .156
*PERF    2   *IJK  4  1 1 1  1 1 2  1 1 3  1 1 4   17.58    1.95   0.625  .156
*PERF    3   *IJK  4  1 5 1  1 5 2  1 5 3  1 5 4   35.17    3.91   1.25   .312
*BHP     1  100   6500
*BHP     2  4550  6500
*BHP     3  100   6500
*C
*Q   1    20.0
*Q   2    25.0
*Q   3     0.0
*C
*WI 1 .01197
*WI 2 .02394
*WI 3 .01197
*C
*TRNMOD  *TY  1 1  2 5  1 4  *MULTIPLY  0.50
*TRNMOD  *TZ  1 1  1 1  2 4  *MULTIPLY  0.125
```

```
*TRNMOD  *TZ  1 1  2 4  2 4  *MULTIPLY  0.50
*TRNMOD  *TZ  1 1  5 5  2 4  *MULTIPLY  0.125
*C
*TRNMOD  *TX  2 5  5 5  1 4  *MULTIPLY  0.50
*TRNMOD  *TZ  2 4  5 5  2 4  *MULTIPLY  0.50
*TRNMOD  *TZ  5 5  5 5  2 4  *MULTIPLY  0.125
                                       *C
*TRNMOD  *TZ  2 2  2 2  2 4  *MULTIPLY 0.5
*TRNMOD  *TZ  3 3  3 3  2 4  *MULTIPLY 0.5
*TRNMOD  *TZ  4 4  4 4  2 4  *MULTIPLY 0.5
                                       *C
*C
*WPLOT    1
•C
*PRINT   *ARRAYS   *WELL   *TONLY
*WMAP  *TONLY
*TIME      1
*TIME      5
*TIME     10
*TIME     50
*TIME    100
*TIME    l82
*PRINT   *ARRAYS   *WELL   *TONLY
*WMAP  *TONLY
*TIME    365
*C
*C
*TIME    547
*PRINT   *ARRAYS   *WELL   *TONLY
*WMAP  *TONLY
*TIME    730
*TIME    912
*PRINT   *ARRAYS   *WELL   *TONLY
*WMAP  *TONLY
*TIME   1095
*TIME   1277
*PRINT   *ARRAYS   *WELL   *TONLY
*WMAP  *TONLY
*TIME   1460
*TIME   1642
*PRINT   *ARRAYS   *WELL   *TONLY
*WMAP  *TONLY
*TIME   1825
*TIME   2190
*TIME   2555
*PRINT   *ARRAYS   *WELL   *TONLY
*WMAP  *TONLY
*TIME   2920
*TIME   3285
*TIME   3650
*TIME   4015
*TIME   4380
*PRINT   *ARRAYS   *WELL   *TONLY
*WMAP  *TONLY
*TIME   4745
*TIME   5110
*TIME   5475
*TIME   5840
*TIME   6205
*TIME   6440
*C
*Q   1    10.0
*Q   2    50.0
*Q   3    15.0
*C
*PRINT   *ARRAYS   *WELL   *TONLY
*WMAP  *TONLY
```

```
*TIME   6450
*TIME   6570
*TIME   6935
*PRINT *ARRAYS *WELL *TIME
*WMAP  *TIME
*TIME   7300
*TIME   9125
*TIME   10950
*TIME   12775
*TIME   14600
*TIME   16425
*TIME   17600
*C
*ENDJOB
```

TIME STEP SUMMARY

------- TIME -------		---- PRODUCTION ----			WATER	------ INJECTION ------		AVG
		OIL	GAS	GOR	CUT	GAS	WATER	PRESS
STEP	DAYS	STB/D	MSCF/D	SCF/STB	FRACT	MSCF/D	STB/D	PSIA
1	1.00	20	11	535	0.000	0	25	3041
2	2.28	20	11	535	0.000	0	25	3042
3	4.45	20	11	535	0.000	0	25	3042
4	5.00	20	11	535	0.000	0	25	3042
5	10.00	20	11	535	0.000	0	25	3042
6	15.31	20	11	535	0.000	0	25	3042
7	22.13	20	11	535	0.000	0	19	3038
8	34.11	20	11	535	0.000	0	16	3029
9	50.00	20	11	535	0.000	0	15	3014
10	73.59	20	11	535	0.000	0	14	2991
11	100.0	20	11	535	0.000	0	14	2966
12	147.2	20	11	535	0.000	0	16	2927
13	182.0	20	11	535	0.000	0	17	2902
14	276.4	20	11	535	0.000	0	18	2845
15	365.0	20	11	535	0.000	0	19	2800
16	547.0	20	11	535	0.000	0	21	2729
17	730.0	20	11	535	0.000	0	22	2681
18	912.0	20	11	535	0.000	0	23	2646
19	1095	20	11	535	0.000	0	24	2622
20	1277	20	11	535	0.000	0	24	2604

												TIME	I	DATA
TIME	----- MATERIAL BALANCES -----			-- MAX SATN CHG --				- MAX PRESS CHG -				STEP	T	OUT-
STEP	OIL	GAS	WATER	I	J	K	DSMAX	I	J	K	DPMAX	CUTS	N	PUT
1	1.0001	1.0001	0.9999	1	1	1	0.003	5	5	1	-312.8	0	2	PM
2	1.0001	1.0001	0.9999	1	1	1	0.004	5	5	1	-236.2	0	2	P
3	1.0001	1.0001	1.0000	1	1	1	0.006	1	1	2	235.4	0	2	P
4	1.0001	1.0001	0.9999	1	1	1	-0.002	1	1	2	58.1	0	1	P
5	1.0003	1.0003	0.9998	1	1	1	-0.016	1	1	2	376.9	0	2	P
6	1.0003	1.0003	0.9998	1	1	1	0.017	1	1	2	311.1	0	2	P
7	1.0003	1.0003	0.9998	1	1	1	0.018	1	1	3	227.8	0	2	P
8	1.0002	1.0002	0.9998	1	1	1	0026	1	1	4	230.2	0	2	P
9	1.0001	1.0001	0.9999	1	1	1	-0.030	1	1	4	203.2	0	2	P
10	1.0001	1.0001	0.9999	1	1	1	-0.036	5	5	4	-218.6	0	2	P
11	1.0000	1.0000	1.0000	1	1	1	-0.033	5	5	4	-190.7	0	1	P
12	1.0000	1.0000	1.0000	1	1	1	-0.041	5	5	4	-215.4	0	2	P
13	1.0000	1.0000	1.0000	1	1	1	-0.024	5	5	4	-112.6	0	1	P
14	1.0000	1.0000	1.0000	1	2	1	0.063	5	5	4	-152.7	0	1	P
15	1.0000	1.0000	1.0000	1	2	1	0.050	3	5	2	-92.7	0	1	PM
16	1.0000	1.0000	1.0000	1	2	1	0.062	1	5	2	-134.8	0	1	P
17	1.0000	1.0000	1.0000	2	2	1	0.067	4	4	3	-101.2	0	1	PM
18	1.0001	1.0001	0.9999	1	3	1	-0.053	3	5	3	-78.2	0	1	P
19	1.0001	1.0001	0.9999	2	3	1	0.042	1	5	3	-65.0	0	1	PM
20	1.0001	1.0001	0.9999	2	3	1	0.044	4	4	4	-55.1	0	1	P

TIME STEP SUMMARY

------- TIME -------		---- PRODUCTION ----			WATER	------ INJECTION ------		AVG
		OIL	GAS	GOR	CUT	GAS	WATER	PRESS
STEP	DAYS	STB/D	MSCF/D	SCF/STB	FRACT	MSCF/D	STB/D	PSIA
21	1460	20	11	535	0.000	0	24	2592
22	1642	20	11	535	0.000	0	25	2583
23	1825	20	11	535	0.000	0	25	2578
24	2008	20	11	535	0.000	0	25	2573
25	2190	20	11	535	0.000	0	25	2570
26	2373	20	11	535	0.000	0	25	2568
27	2555	20	11	535	0.000	0	25	2566
28	2738	20	11	535	0.000	0	25	2565
29	2920	20	11	535	0.000	0	25	2564
30	3103	20	11	535	0.000	0	25	2562
31	3285	20	11	535	0.000	0	25	2561
32	3468	20	11	535	0.000	0	25	2559
33	3650	20	11	535	0.001	0	25	2556
34	3833	20	11	535	0.003	0	25	2550
35	4015	20	11	535	0.023	0	25	2538
36	4198	20	11	535	0.102	0	25	2498
37	4380	18	10	535	0.226	0	25	2447
38	4563	15	8	535	0.338	0	25	2419
39	4745	13	7	535	0.416	0	25	2402
40	4928	12	7	535	0.469	0	25	2383

												TIME	I	DATA
TIME	----- MATERIAL BALANCES -----			-- MAX	SATN	CHG --		- MAX	PRESS	CHG -		STEP	T	OUT-
STEP	OIL	GAS	WATER	I	J	K	DSMAX	I	J	K	DPMAX	CUTS	N	PUT
21	1.0001	1.0001	0.9999	2	3	1	-0.040	2	3	1	50.5	0	1	PM
22	1.0002	1.0002	0.9999	1	4	1	0.033	4	4	4	-43.0	0	1	P
23	1.0002	1.0002	0.9999	3	3	1	0.036	1	4	1	39.2	0	1	PM
24	1.0002	1.0002	0.9999	3	3	1	-0.036	1	2	2	37.8	0	1	P
25	1.0002	1.0002	0.9999	3	3	1	-0.033	3	3	1	36.8	0	1	P
26	1.0002	1.0002	0.9999	2	4	1	-0.028	1	2	2	30.9	0	1	P
27	1.0002	1.0002	0.9999	3	4	1	-0.027	2	4	1	29.6	0	1	P
28	1.0002	1.0002	0.9999	3	4	1	0.031	1	5	1	29.9	0	1	P
29	1.0002	1.0002	0.9999	3	4	1	-0.031	1	5	1	30.3	0	1	PM
30	1.0002	1.0002	0.9999	3	4	1	-0.029	1	5	1	29.1	0	1	P
31	1.0002	1.0002	0.9999	4	4	1	0.032	1	5	1	29.1	0	1	P
32	1.0002	1.0002	0.9999	4	4	1	-0.037	5	5	1	-47.7	0	1	P
33	1.0002	1.0002	0.9999	4	4	1	-0.036	5	5	1	-84 3	0	1	P
34	1.0002	1.0002	0.9998	4	5	1	0.037	5	5	1	-109 3	0	1	P
35	1.0002	1.0002	0.9995	5	5	1	0.057	5	5	2	-164.9	0	1	P
36	1.0002	1.0002	0.9995	5	5	1	-0.086	5	5	2	-289.1	0	2	P
37	1.0002	1.0002	0.9993	5	5	1	-0.065	5	5	4	-201.0	0	2	P
38	1.0002	1.0002	0.9993	5	5	1	-0.031	4	5	4	-79.2	0	2	P
39	1.0000	1.0000	0.9991	5	5	1	0.019	4	4	4	-60 6	0	1	PM
40	1.0000	1.0000	0.9991	4	5	1	0.013	4	4	4	-53 3	0	1	P

TIME STEP SUMMARY

------- TIME -------		---- PRODUCTION ----			WATER	------ INJECTION ------		AVG
		OIL	GAS	GOR	CUT	GAS	WATER	PRESS
STEP	DAYS	STB/D	MSCF/D	SCF/STB	FRACT	MSCF/D	STB/D	PSIA
41	5110	11	6	535	0.508	0	25	2364
42	5293	11	6	535	0.539	0	25	2346
43	5475	10	5	535	0.564	0	25	2328
44	5658	10	5	535	0.584	0	25	2309
45	5840	9	5	535	0.601	0	25	2290
46	6023	9	5	535	0.616	0	25	2272
47	6205	9	5	535	0.629	0	25	2255
48	6388	9	5	535	0.641	0	25	2237
49	6440	9	5	535	0.643	0	25	2232
50	6450	23	13	535	0.613	0	31	2196
51	6526	23	12	535	0.591	0	36	1993
52	6570	23	12	535	0.587	0	38	1895
53	6619	22	12	535	0.586	0	40	1802
54	6692	22	12	535	0.590	0	43	1683
55	6818	20	11	535	0.612	0	45	1543
56	6935	18	10	535	0.634	0	46	1450
57	7118	16	9	535	0.661	0	47	1351
58	7300	15	8	535	0.680	0	47	1278
59	7483	14	8	535	0.697	0	48	1221
60	7665	14	7	535	0.712	0	48	1177

												TIME	I	DATA
TIME	---- MATERIAL BALANCES -----			-- MAX	SATN	CHG --		- MAX	PRESS	CHG -		STEP	T	OUT-
STEP	OIL	GAS	WATER	I	J	K	DSMAX	I	J	K	DPMAX	CUTS	N	PUT
41	1.0000	1.0000	0.9991	4	5	1	-0.011	4	4	4	-46.7	0	1	P
42	1.0000	1.0000	0.9991	4	5	1	-0.009	4	4	4	-41.1	0	1	P
43	0.9999	0.9999	0.9991	2	2	2	0.008	3	4	4	-38.0	0	1	P
44	0.9999	0.9999	0.9992	1	3	1	0.008	3	4	4	-35.9	0	1	P
45	0.9999	0.9999	0.9992	1	3	1	0.008	3	4	4	-33.9	0	1	P
46	0.9999	0.9999	0.9992	1	3	1	-0.008	1	5	4	-33.2	0	1	P
47	0.9999	0.9999	0.9993	1	3	1	-0.007	1	5	4	-32.6	0	1	P
48	0.9999	0.9999	0.9993	1	3	1	0.007	1	5	4	-31.8	0	1	P
49	0.9999	0.9999	0.9993	1	3	1	-0.002	1	5	4	-9.1	0	1	P
50	0.9999	0.9999	0.9993	1	5	1	-0.001	1	5	1	-955.7	0	6	PM
51	0.9999	0.9999	0.9993	1	5	1	-0.021	1	5	3	-834.1	0	5	P
52	0.9999	0.9999	0.9994	1	5	1	0.010	1	5	4	-358.4	0	2	P
53	0.9999	0.9999	0.9994	1	5	1	-0.010	1	5	4	-264.5	0	2	P
54	0.9999	0.9999	0.9994	1	5	1	-0.011	1	5	4	-233.3	0	2	P
55	0.9999	0.9999	0.9995	1	5	1	-0.011	2	3	2	-261.9	0	2	P
56	0.9999	0.9999	0.9995	1	3	2	-0.008	2	3	3	-189.0	0	1	P
57	0.9999	0.9999	0.9995	1	3	2	0.012	2	2	3	-244.1	0	2	P
58	0.9997	0.9997	0.9995	1	3	2	-0.012	2	2	3	-187.8	0	1	PM
59	0.9997	0.9997	0.9996	1	3	2	-0.011	2	4	4	-134.0	0	1	P
60	0.9997	0.9997	0.9996	1	3	2	-0.011	2	3	4	-131.5	0	1	P

TIME STEP SUMMARY

------- TIME -------		---- PRODUCTION ----			WATER	------ INJECTION ------		AVG
		OIL	GAS	GOR	CUT	GAS	WATER	PRESS
STEP	DAYS	STB/D	MSCF/D	SCF/STB	FRACT	MSCF/D	STB/D	PSIA
61	7848	13	7	535	0.725	0	48	1141
62	8030	12	7	535	0.736	0	49	1111
63	8213	12	6	535	0.745	0	49	1086
64	8395	12	6	535	0.754	0	49	1065
65	8578	11	6	535	0.761	0	49	1047
66	8760	11	6	535	0.768	0	49	1032
67	8943	11	6	535	0.775	0	50	1019
68	9125	10	6	535	0.780	0	50	1008
69	9308	10	5	535	0.786	0	50	998
70	9490	10	5	535	0.791	0	50	991
71	9673	10	5	535	0.796	0	50	984
72	9855	10	5	535	0.800	0	50	979
73	10038	9	5	535	0.804	0	50	974
74	10220	9	5	535	0.808	0	50	970
75	10403	9	5	535	0.812	0	50	967
76	10585	9	5	535	0.816	0	50	965
77	10768	9	5	535	0.819	0	50	963
78	10950	8	5	535	0.823	0	50	962
79	11133	8	4	535	0.826	0	50	961
80	11315	8	4	535	0.829	0	50	961

TIME	---- MATERIAL BALANCES -----			-- MAX	SATN	CHG --		- MAX	PRESS	CHG -		TIME STEP	I T	DATA OUT-
STEP	OIL	GAS	WATER	I	J	K	DSMAX	I	J	K	DPMAX	CUTS	N	PUT
61	0.9997	0.9997	0.9996	2	3	2	0.011	2	3	4	-126.0	0	1	P
62	0.9997	0.9997	0.9996	2	3	2	-0.011	2	2	4	-122.8	0	1	P
63	0.9997	0.9997	0.9996	2	3	2	-0.011	2	2	4	-117.5	0	1	P
64	0.9997	0.9997	0.9997	2	3	2	0.011	2	2	4	-110.1	0	1	P
65	0.9997	0.9997	0.9997	2	3	2	0.011	1	2	4	-104.2	0	1	P
66	0.9997	0.9997	0.9997	2	3	2	-0.010	1	2	4	-97.0	0	1	P
67	0.9997	0.9997	0.9997	1	4	2	0.010	1	2	4	-88.6	0	1	P
68	0.9997	0.9997	0.9997	1	4	2	-0.010	1	2	4	-79.5	0	1	PM
69	0.9997	0.9997	0.9997	1	4	2	-0.010	1	2	4	-70.1	0	1	P
70	0.9997	0.9997	0.9997	1	4	2	-0.010	1	2	4	-61.0	0	1	P
71	0.9997	0.9997	0.9997	1	4	2	-0.010	1	2	4	-52.3	0	1	P
72	0.9997	0.9997	0.9997	1	4	2	-0.009	1	2	4	-44.6	0	1	P
73	0.9997	0.9997	0.9998	1	4	2	0.009	1	2	4	-37.6	0	1	P
74	0.9998	0.9998	0.9998	1	4	2	-0.009	1	2	4	-30.2	0	1	P
75	0.9998	0.9998	0.9998	1	5	2	0.009	2	2	4	-24.5	0	1	P
76	0.9998	0.9998	0.9998	1	5	2	-0.010	2	2	4	-20.3	0	1	P
77	0.9998	0.9998	0.9998	1	5	2	-0.010	2	2	4	-16.8	0	1	P
78	0.9998	0.9998	0.9998	1	5	2	0.011	2	2	4	-13.8	0	1	PM
79	0.9998	0.9998	0.9998	1	5	2	0.011	2	2	3	14.9	0	1	P
80	0.9998	0.9998	0.9998	1	5	2	-0.011	2	2	3	14.9	0	1	P

TIME STEP SUMMARY

TIME STEP	TIME DAYS	PRODUCTION OIL STB/D	PRODUCTION GAS MSCF/D	GOR SCF/STB	WATER CUT FRACT	INJECTION GAS MSCF/D	INJECTION WATER STB/D	AVG PRESS PSIA
81	11498	8	4	535	0.832	0	50	962
82	11680	8	4	535	0.835	0	50	962
83	11863	8	4	535	0.838	0	50	963
84	12045	8	4	535	0.841	0	50	965
85	12228	7	4	535	0.844	0	50	966
86	12410	7	4	535	0.847	0	50	968
87	12593	7	4	535	0.850	0	50	969
88	12775	7	4	535	0.853	0	50	971
89	12958	7	4	535	0.856	0	50	973
90	13140	7	4	535	0.859	0	50	975
91	13323	7	4	535	0.861	0	50	976
92	13505	7	4	535	0.864	0	50	978
93	13688	6	3	535	0.866	0	50	980
94	13870	6	3	535	0.868	0	50	982
95	14053	6	3	535	0.870	0	50	983
96	14235	6	3	535	0.872	0	50	985
97	14418	6	3	535	0.874	0	50	986
98	14600	6	3	535	0.876	0	50	988
99	14783	6	3	535	0.878	0	50	989
100	14965	6	3	535	0.880	0	50	991

TIME STEP	MATERIAL BALANCES OIL	MATERIAL BALANCES GAS	MATERIAL BALANCES WATER	MAX SATN CHG I	J	K	DSMAX	MAX PRESS CHG I	J	K	DPMAX	TIME STEP CUTS	ITN	DATA OUT-PUT
81	0.9998	0.9998	0.9998	1	5	2	-0.011	2	2	3	15.7	0	1	P
82	0.9998	0.9998	0.9998	1	5	2	0.011	2	2	3	16.5	0	1	P
83	0.9998	0.9998	0.9998	1	5	2	0.011	2	2	3	17.3	0	1	P
84	0.9998	0.9998	0.9998	1	5	2	0.010	2	2	3	16.1	0	1	P
85	0.9998	0.9998	0.9998	1	5	2	-0.010	2	2	3	16.8	0	1	P
86	0.9998	0.9998	0.9998	1	5	2	0.009	2	2	3	17.8	0	1	P
87	0.9999	0.9999	0.9998	1	5	2	-0.009	2	2	3	17.8	0	1	P
88	0.9999	0.9999	0.9998	1	5	2	-0.008	2	2	3	15.3	0	1	PM
89	0.9999	0.9999	0.9998	1	5	2	-0.007	2	2	3	15.8	0	1	P
90	0.9999	0.9999	0.9998	1	5	2	-0.007	2	2	3	15.7	0	1	P
91	0.9999	0.9999	0.9998	1	5	2	-0.006	2	2	3	15.6	0	1	P
92	0.9999	0.9999	0.9998	1	5	2	-0.006	2	2	3	11.9	0	1	P
93	0.9999	0.9999	0.9998	1	3	3	0.006	2	2	3	12.1	0	1	P
94	0.9999	0.9999	0.9998	1	3	3	0.006	2	2	3	12.0	0	1	P
95	0.9999	0.9999	0.9998	1	3	3	-0.005	1	2	4	12.3	0	1	P
96	0.9999	0.9999	0.9999	1	3	3	0.005	1	2	4	12.1	0	1	P
97	0.9999	0.9999	0.9999	2	5	2	0.005	1	2	4	12.3	0	1	P
98	0.9999	0.9999	0.9999	2	5	2	-0.005	1	2	4	12.5	0	1	PM
99	0.9999	0.9999	0.9999	2	5	2	-0.005	1	2	4	12.7	0	1	P
100	0.9999	0.9999	0.9999	2	5	2	0.005	1	2	4	12.8	0	1	P

TIME STEP SUMMARY

------- TIME -------		---- PRODUCTION ----			WATER	------ INJECTION ------		AVG
		OIL	**GAS**	GOR	**CUT**	**GAS**	**WATER**	**PRESS**
STEP	DAYS	STB/D	MSCF/D	**SCF/STB**	FRACT	MSCF/D	STB/D	PSIA
101	15148	6	3	535	0.881	0	50	992
102	15330	6	3	535	0.883	0	50	993
103	15513	6	3	535	0.884	0	50	995
104	15695	6	3	535	0.886	0	50	996
105	15878	5	3	535	0.887	0	50	997
106	16060	5	3	535	0.888	0	50	998
107	16243	5	3	535	0.890	0	50	1000
108	16425	5	3	535	0.891	0	50	1001
109	16608	5	3	535	0.893	0	50	1002
110	16790	5	3	535	0.894	0	50	1004
111	16973	5	3	535	0.895	0	50	1005
112	17155	5	3	535	0.896	0	50	1006
113	17338	5	3	535	0.898	0	50	1007
114	17520	5	3	535	0.899	0	50	1009
115	17600	5	3	535	0.899	0	50	1009

												TIME	I	DATA
TIME	---- MATERIAL BALANCES -----			-- MAX SATN CHG --				- MAX PRESS CHG -				STEP	T	OUT-
STEP	OIL	GAS	WATER	I	J	K	DSMAX	I	J	K	DPMAX	CUTS	N	PUT
101	0.9999	0.9999	0.9999	2	5	2	-0.005	1	2	4	13.0	0	1	P
102	0.9999	0.9999	0.9999	2	5	2	0.005	1	2	4	13.1	0	1	P
103	0.9999	0.9999	0.9999	2	5	2	0.005	1	2	4	13.7	0	1	P
104	0.9999	0.9999	0.9999	2	5	2	-0.005	1	2	4	13.1	0	1	P
105	0.9999	0.9999	0.9999	2	5	2	-0.005	1	2	4	13.2	0	1	P
106	0.9999	0.9999	0.9999	2	5	2	-0.005	1	2	4	13.3	0	1	P
107	0.9999	0.9999	0.9999	2	5	2	0.005	1	2	4	13.4	0	1	P
108	0.9999	0.9999	0.9999	2	5	2	-0.004	1	2	4	13.5	0	1	PM
109	0.9999	0.9999	0.9999	2	5	2	-0.004	1	2	4	13.5	0	1	P
110	0.9999	0.9999	0.9999	2	5	2	-0.004	1	2	4	13.6	0	1	P
111	0.9999	0.9999	0.9999	2	5	2	-0.004	1	2	4	13.0	0	1	P
112	0.9999	0.9999	0.9999	2	3	3	0.004	1	2	4	12.8	0	1	P
113	0.9999	0.9999	0.9999	2	3	3	-0.004	1	2	4	12.6	0	1	P
114	0.9999	0.9999	0.9999	2	3	3	0.004	1	2	4	12.5	0	1	P
115	0.9999	0.9999	0.9999	2	3	3	0.002	1	2	4	5.5	0	1	PM

APPENDIX 2a
SPE REFERENCE PAPERS FOR IDPM VALIDATION AGAINST FIELD FLOOD RESULTS

SPE 15568

Quantitative Analysis of Infill Performance: Robertson Clearfork Unit

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Summary

This study analyzed the results of 218 infill wells drilled in the Robertson Clearfork Unit (RCU), Gaines County, TX. This program increased ultimate recovery by more than 23 million bbl [$3.7x10^6$ m^3]. The individual well performance, as a function of reservoir continuity, was analyzed quantitatively with pressure correlations, numerical analyses, and geologic study.

Introduction

Infill drilling has significantly increased the cumulative production, conventional remaining reserves, and EOR prospects in RCU. This paper documents the successful infill program and the techniques used to quantify reservoir performance under various well spacing and injection patterns.

RCU is a highly stratified, lenticular dolomite reservoir. Continuity of pay between wells is unusually poor, and the reservoir was only partially drained by wells on 40-acre [16-ha] spacing. Ultimately, 10-acre [4-ha] wells and 40-acre [16-ha] inverted nine-spot patterns were required for an effective waterflood, Expected recovery from the unit has been increased by more that 23 million bbl [$3.8x10^6$ m^3] by the drilling of 218 infill wells and an increase in the number of water-injection wells to form the 40-acre [16-ha] inverted nine-spot patterns. (Throughout this paper, 10-, 20-, and 40-acre [4-, 8-, and 16-ha] spacing refers to the nominal spacing of wells, although the exact areas vary.)

Three approaches were used to quantify reservoir continuity as a function of horizontal distance: geologic correlation, pressure-transient behavior, and regression analysis of infill performance. All three techniques indicate that 10-acre [4-ha] spacing can effective drain 80 to 85% of the reservoir volume by primary production (solution gas drive). On this spacing, however, reservoir discontinuities limit the floodable volume to only 60 to 65% of the total reservoir.

These studies have permitted the operator to project the results of further infill drilling quantitatively. They also permit a realistic assessment of EOR potential based on actual floodable reservoir volume calculations.

Background

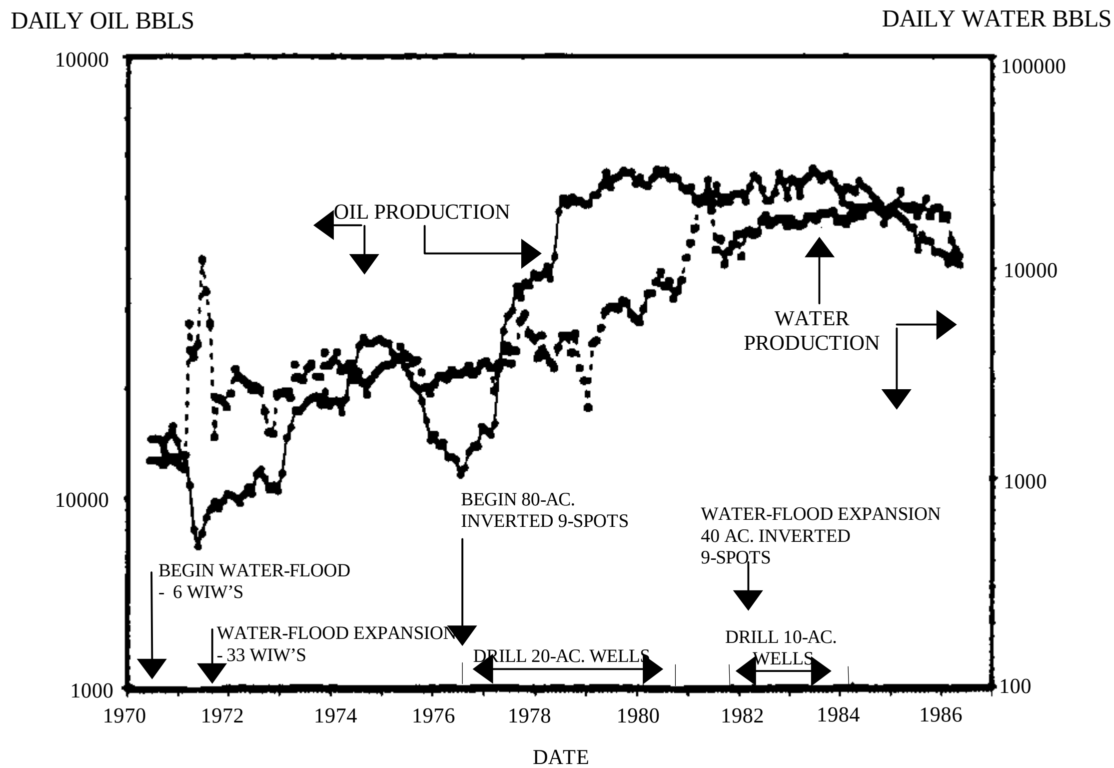
RCU became effective Jan. 1, 1970, and injection began in the first six injectors almost immediately. By mid-1971, the waterflood had been expanded throughout the unit. Full-scale injection averaged 20,000 to 30,000 BWPD [$3.2x10^3$ to $4.8x10^3$ m^3/d water] throughout the 1970's, and by 1974, a degree of reservoir fill-up caused an oil production increase. The response peaked briefly in 1974 at 3,500 BOPD [560 m^3/d oil] and then began a rapid >25%/yr decline (see Fig. 1). This precipitous decline, and the low ultimate secondary recovery it foretold, prompted the first major reservoir performance review in 1975 and 1976. This marked the beginning of the successful infill drilling program described here.

The first RCU discovery within the unit boundary was in 1946. The field was subsequently named the Doss (Upper Clearfork) field. In 1970, after additional new zone discoveries and various field consolidations by the Texas Railroad Commission, the unitized reservoir consisted of two separate regulatory fields: the Robertson, North (Clearfork 7,100) field, which included the RCU Lower Clearfork, and the Robertson field, which included the Glorieta formation and the Upper Clearfork.

The two reservoirs were first flooded under a "confluent production" program in which dually completed injectors flooded each zone separately while production was commingled in the producers. Then, in 1977, the injection wells were commingled, and the entire unitized formation has been operated as a single reservoir since. Reservoir performance studies, as well as injection profile tests, indicate that the waterflood conformance was no worse under the commingled mode than under the previous operation.

The 1976 reservoir study identified two major problems in waterflood performance: inadequate completions and poor reservoir continuity. Extrapolation of production curves forecast an ultimate recovery of only 30 million bbl [$4.8x10^6$ m^3], 8.3% of the original oil in place (OOIP), with the initial operating scheme. This could be improved to 42 million bbl [$6.7x10^6$ m^3] by an extensive workover program of perforating additional intervals and selective stimulation. The problem of poor reservoir continuity, however, could be overcome only by infill drilling on closer spacing. Detailed zone-by-zone geologic correlations of porous intervals were developed with techniques reported by George and Stiles.[1] These were used to evaluate continuity between wells and thus to estimate recovery from 20-acre [8-ha] wells.

Fig. 1 -- Production history

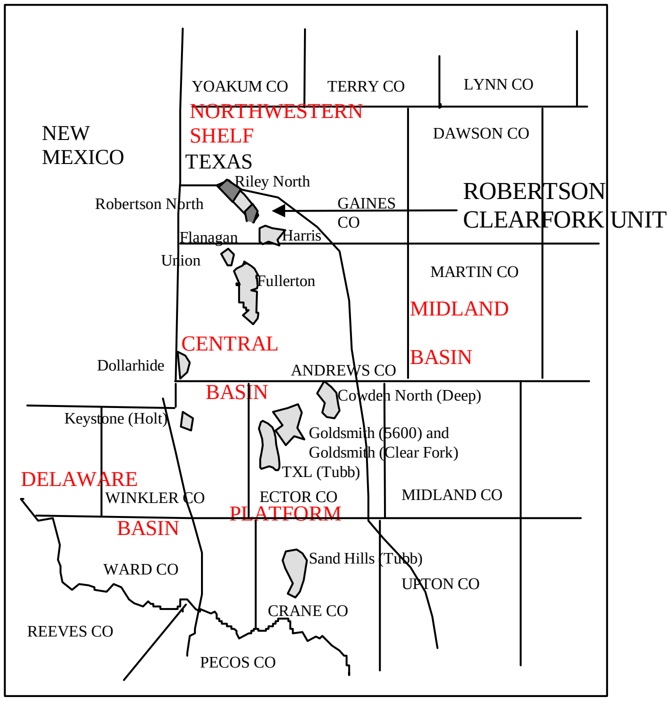


Reservoir Geology

Regional Overview. Geologically, the Robertson field is located on the northeastern edge of the Central Basin platform, which separated the Delaware and Midland basins during the Permian Age (Fig. 2). Production is from Permian Leonardian carbonates of the Glorieta, Upper Clearfork, and Lower Clearfork formations.

The 13 Clearfork fields shown in Fig. 2 have many similar geologic features and demonstrate the effect the Central Basin platform had on Permian carbonate development and stratigraphy. The uplift of the Central Basin platform provided a shallow platform where prolific biological activity could occur, thereby allowing the accumulation of abundant carbonate sediments. Progressive deepening of the basin and growth of a marine bank along the margin of the basin accentuated the environmental differences between the basin and shelf areas. An idealized block diagram, shown in Fig. 3, illustrates a shelf margin complex similar to the environment that produced the Robertson carbonates. Hypersaline waters were more common shoreward of the marine bank, with several areas periodically subaerially exposed. Near-normal marine conditions prevailed farther basinward along the platform. Carbonate deposition would tend to build upward and basinward, subject to later dolomitization.

Fig 2 -- Location map of RCU and other Clearfork reservoirs (adapted from Ref. 2).



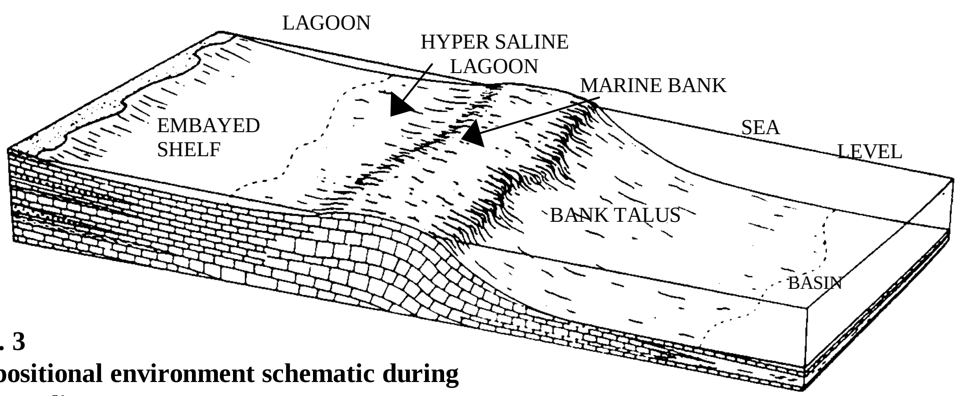
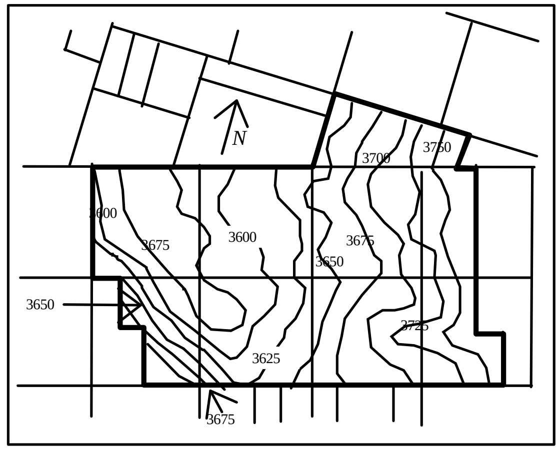


Fig. 3
Depositional environment schematic during Leonardian Age.

Trapping Mechanism. The Robertson field is situated on a large northwest/southeast-trending anticline, though most of the trapping of hydrocarbons is controlled by lateral and vertical limits of porosity and permeability Most Clearfork reservoirs on the Central Basin platform exhibit a similar stratigraphic trapping mechanism.[2]

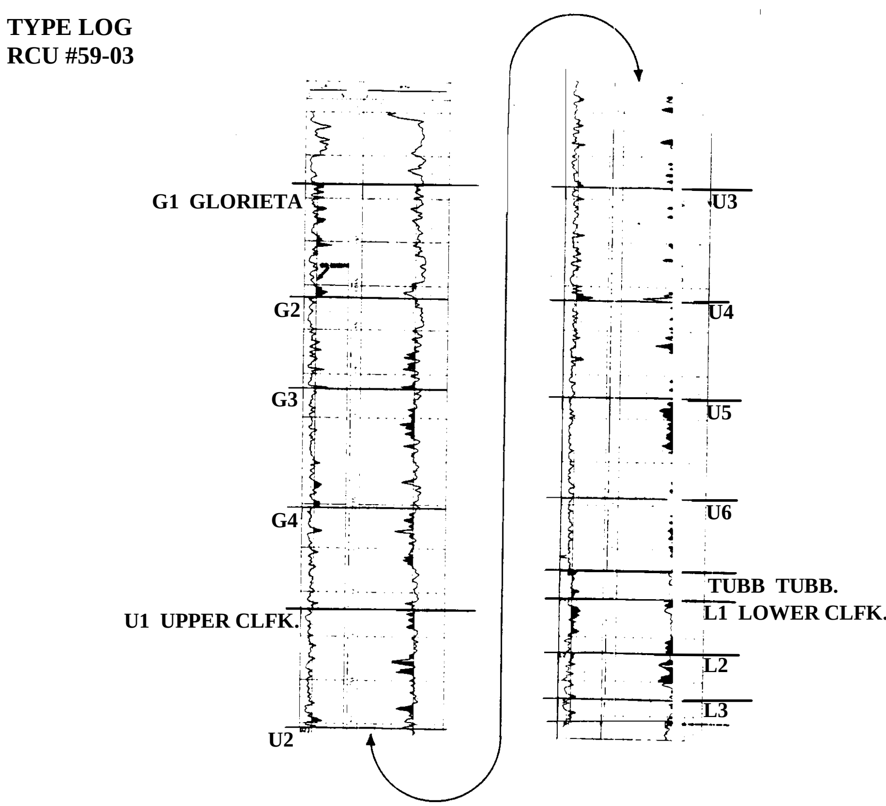
Fig. 4. is a structural map on the top of the Lower Clearfork formation. The crest of the structure is located on the west side of the unit area, with a gentle dip to the east and a steeper dip to the southwest. The structural maps on other horizons are similar except for some shifting of the crest to the east as the formations become shallower.

Fig 4
Structural map--
top of Lower Clearfork, RCU



Zonation and Lithology. The gross vertical interval at RCU is approximately 1,200 to 1,400 ft [370 to 430 m] thick and occurs from 5,800 to 7,200 ft [1770 to 2200 m] in depth. The net pay within this interval varies from 200 to 400 ft [60 to 120 m]. Fig. 5 is a type log (gamma ray/sidewall neutron porosity) that shows the unitized interval, which consists of the Glorieta, Upper Clearfork, Tubb (nonproductive), and Lower Clearfork formations. This section was subdivided further into 14 zones for detailed mapping (mainly on the basis of gamma ray log response).

Fig. 5 -- Type Log



In general, the unitized interval consists of dolomite, shale, and anhydrite, with minor beds of lignite and sandstone in the Glorieta. The Lower Clearfork is the most heavily dolomitized of all the formations and appears more massive than either the Glorieta or Upper Clearfork.

Porosity types are dominantly moldic and intergranular, though some vugular porosity is present in the Lower Clearfork. Average porosity is approximately 6.0%, and permeability averages 0.1 to 2.0 md.

Note that over the entire vertical interval of 1,200 to 1,400 ft [370 430 m], there may be 50 to 70 different individual pay stringers, ranging in thickness from 1 ft [0.3 m] to a few tens of feet. Fig. 5 shows that most porosity zones are usually only a few feet thick.

Depositional Environment. In general, the heterogeneity and stringerized nature of the carbonates in the Robertson reservoir are a result of their depositional environments. A complex mosaic of environments existed that ranged from supratidal (above mean high tide) to subtidal (below mean low tide). This range of environments would have coexisted while migrating laterally and vertically with time. This "shifting" of environments is probably represented best in the Upper Clearfork by the interbedded shales and dolomite. The cyclic nature of the Upper Clearfork is probably a result of slight variations in sea level or depositional rates as environments altered from subtidal (lime mud, now dolomites) and supratidal (shale and anhydrite). The Lower Clearfork generally appears to be more marine-dominated, although recognition of fossils and structures is difficult because of dolomitization. In contrast, the Glorieta appears to have been deposited more landward, consisting of supratidal-type deposits (shale, anhydrite, and lignite).

Overall, the carbonates built basinward with time, resulting in a regressive sequence. Within this regressive sequence, however, there are also minor transgressive cycles, especially in the Glorieta and Upper Clearfork formations. The regressive sequence can be seen by comparing the net-porosity-feet maps of each formation, as shown in Figs. 6 through 8. Note that the basin would have been toward the east and landward would have been to the west. These maps show a distinct west-to-east shift in the highest net porosity-feet values during the successive deposition of Lower Clearfork to Glorieta sediments as the carbonates progressively built basinward through time.

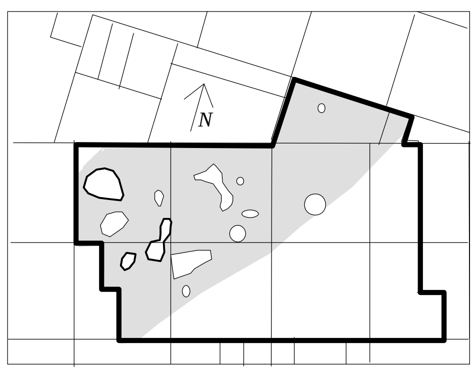


Fig. 6
Lower Clearfork--trend of high quality reservoir.

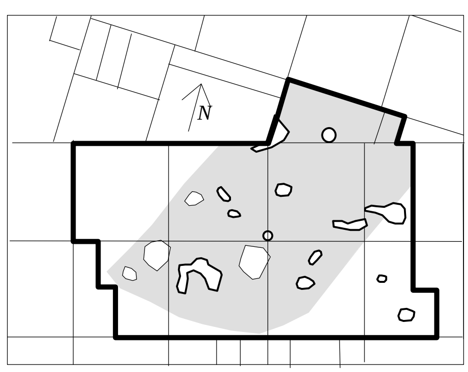


Fig. 7
Upper Clearfork--trend of high quality reservoir.

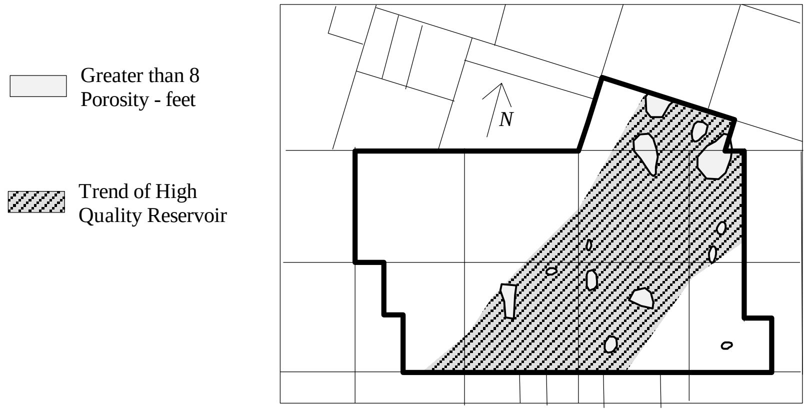


Fig. 8 - Glorieta--trend of high quality reservoir.

Development History

RCU was initially developed with 40 acres [16 ha] per well, with the wells generally arranged in eat/west rows and north/south columns. At the time waterflooding began in 1970-71, every other well was converted to injection, thus creating 80-acre [32-ha] five-spot waterflood patterns. The first round of infill drilling involved drilling one additional well on each 40-acre [16-ha] tract, resulting in a modification of the waterflood pattern to 80-acre [32-ha] inverted nine-spots. In effect, the well density was doubled (Fig. 9).

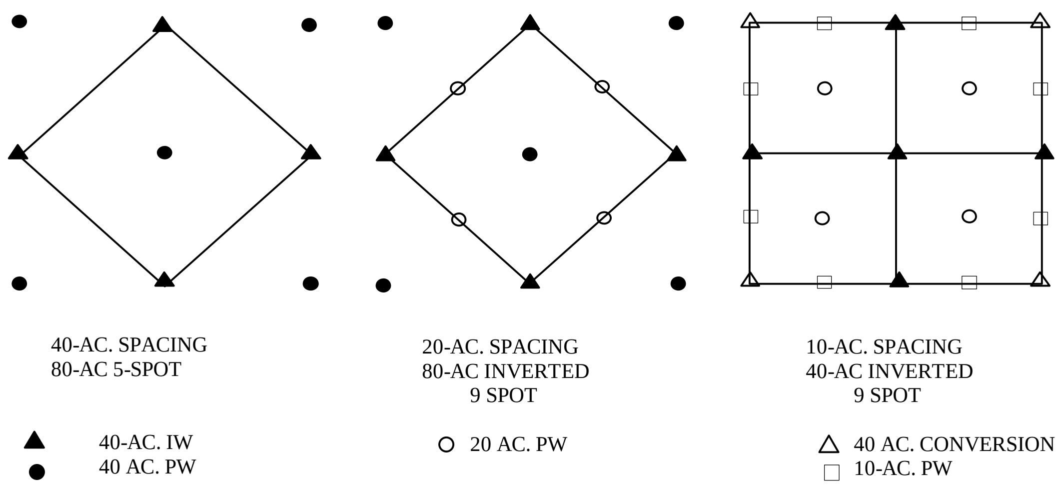


Fig. 9 -- Evolution of waterflood patterns.

The final stage of development involved drilling one well on each undrilled 10-acre [4-ha] location; i.e., one well was drilled directly north and one well directly east/west of each of the original 40-acre [16-ha] wells. This pattern would not have had adequate injectivity to balance withdrawals; therefore, the remaining original 40-acre [16-ha] producing wells were converted to injection service in this area. Thus, the final pattern, which is still in operation, consists of 40 acres [16-ha] per inverted nine-spot pattern with roughly one injection well for each three producing wells.

Pressure Performance

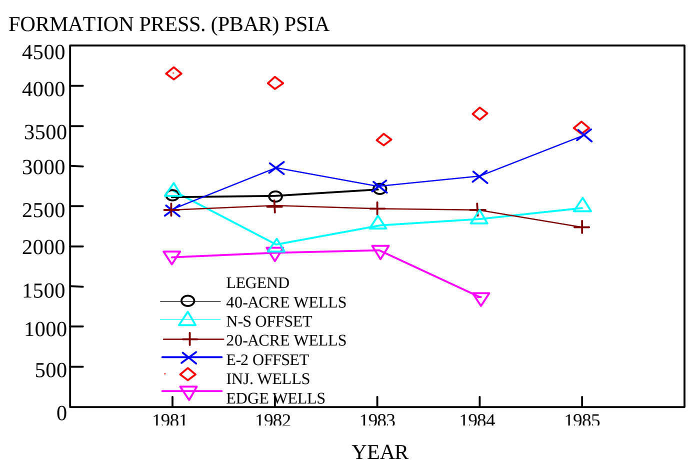
Since 1981, during the time of most of the 10-acre [4-ha] infill drilling at RCU, 197 buildup and falloff tests were run over a wide areal distribution throughout the unit. Analysis of these pressure-transient tests provides invaluable insight into the actual performance within the reservoir. For producing wells, these tests were generally analyzed with McKinley's[3] technique because the relatively low productivity and the high stratification result in very long periods of afterflow in an RCU producer. The typical producing well is affected by afterflow (or by wellbore storage effects) for more than 4 to 5 days after shut-in. The injection-well falloff tests, with short periods of afterflow, can be analyzed by conventional techniques. The fracture length for each of these wells was calculated with the techniques presented by Matthew's and Russell.[4] Table 1 summarizes these tests.

TABLE 1 -- SUMMARY OF RCU PRESSURE-TRANSIENT TESTING
Average value per well

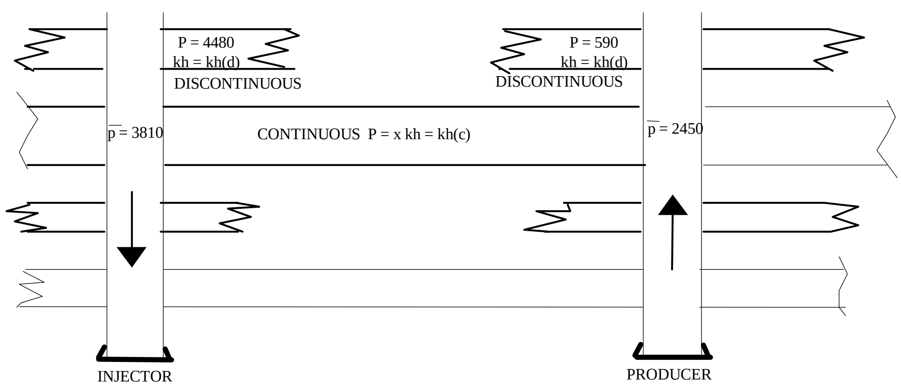
	Producing Wells					
	40-acre Original Producers	North/South Offsets	20-acre Infills	East/West Offsets	Edge Wells	Injectors
Skin factor	0.5	0	-0.6	-1	-0.1	-2.3
Calculated fracture length, ft	1	1	3	13	1	39
Flowing BHP, psi	1,033	601	517	884	667	4,480
Formation pressure, psi	2,610	2,280	2,450	2,860	1,820	3,810
Transmissibility, md-ft/cp	68	307	80	178	139	947

The average reservoir pressure, $\bar{p}$, which is the extrapolated pressure for the vicinity of each well, is presented in Fig. 10. This pressure history should be analyzed and viewed in light of the major modifications occurring in reservoir operations in the 1981-85 period. During this time, the number of active producing wells increased from 140 to 229, while active injectors increased from 40 to 78. Again, one of the first conclusions from these data is that the differential pressure between the injection-well extrapolation and producing-well extrapolation has decreased during the time that the average distance between wells decreased (Fig. 10); i.e., the typical spacing at RCU decreased from 20 to 10 acres [8 to 4 ha] per well during this time. The other pertinent reservoir performance points are shown on this graph. The first is that the producing wells in the waterflooded area have maintained pressure throughout this time. This confirmed that the decision to increase injection from the 80-acre [32-ha] inverted nine-spot pattern to the 40-acre [16-ha] inverted nine-spot pattern was sound and that pressures have been maintained. The other point to note is that the typical east/west offset to the injectors throughout this time period has shown an extrapolated pressure roughly 200 to 300 psi [1.3 to 2.1 MPa] higher than either the north/south offsets or the 20-acre [8-ha] offsets. This tends to confirm a suspected directional permeability or fracture orientation in the east/west direction.

Fig 10
Formation Pressure History
by Well Type



The continuity fraction for an injector/producer pair can be estimated by analyzing their $\bar{p}$'s, in terms of a simple model. The extrapolated pressures in any given wellbore are the result of an average of pressures in the multiple zones that are open at the well-bore. In injectors, some of these zones will be relatively small, undrained, and pressured to the maximum--i.e., stabilized at the bottomhole injection pressure (BHIP). Some of the zones will be continuous to producing wells and, as such, will be at a relatively lower pressure because of the drainage. A similar situation exists in the producing wells, where some discontinuous zones will indeed be completely depleted to the pumping BHP. Other zones will be effectively supported by the offsetting injection. This situation is shown schematically in Fig. 11; there the average extrapolated formation pressure, $\bar{p}$, for all injection well tests is 3,810 psi [26 MPa], which compares to the average BHIP of 4,480 psi [30.9 MPa]. Similarly, in the producing wells, the average $\bar{p}$ of 2,450 psi [16.0 MPa] compares to a pumping BHP of 590 psi [4.1 MPa]. Although the exact relationship from one zone to another is not precisely quantifiable, the overall $\bar{p}$ is approximately representative of a permeability/thickness weighted average of pressures in all the zones open in the wellbore. This assumption permits the solution of two equations with two unknowns, also shown in Fig. 11. The results shown in Fig. 11 represent the averages of all tests run from 1981 through 1985. The calculated reservoir continuity, which is the percentage of zones open in both producing wells and injection wells, is about 65%. The similar percentage of discontinuous reservoir, of course, is 35%.



ASSUME: WELLBORE $\bar{p}$ = kh WEIGHTED AVERAGE

<u>THEN FOR WIW:</u>

Pwf = 4480

$\bar{p}$ = 3810

$$3810 = \frac{4480 \cdot kh(d) - x \cdot kh(c)}{kh(c) - kh(d)}$$

kh(c) + kh(d) = 1

kh(c) = .65

kh(d) = .35

x = 3450psi

<u>FOR PROD.:</u>

Pwf = 590

$\bar{p}$ = 2450

$$2450 = \frac{590 \cdot kh(d) + x \cdot kh(c)}{kh(c) + kh(d)}$$

Fig. 11 -- Average zonal pressures--schematic cross section.

The other unknowns, the average pressure, which is the pressure roughly halfway between the two wells, is 3,450 psi [23.8 MPa]. As will be discussed, this is very similar to pressures identified by wireline formation pressure tests. Applying a similar technique to the pressure differential between injectors and producers at different spacings yields a spread from about 71% continuity at 660 ft [200 m] to less than 50% continuity at 2,000 ft [610 m]. These data are plotted in Fig. 12 and compared with estimates by other techniques.

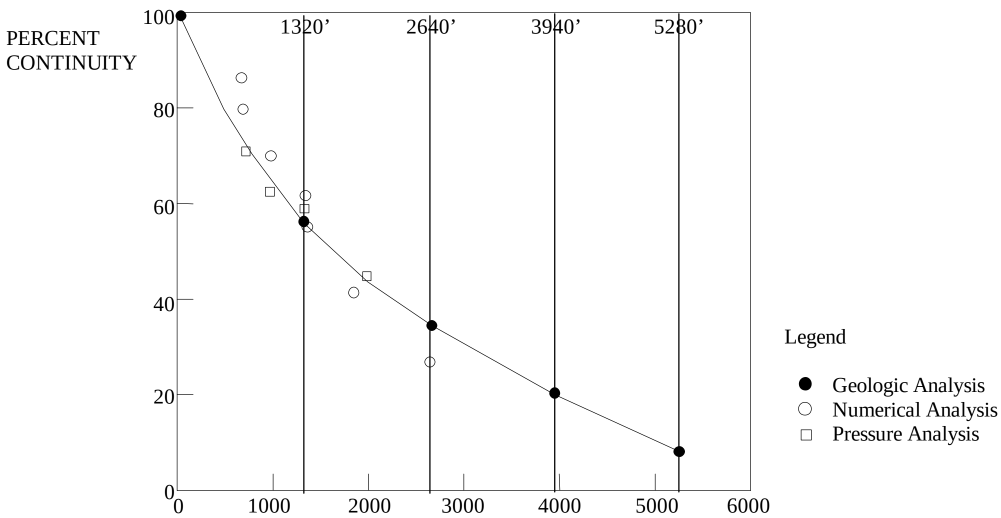


Fig. 12 -- Reservoir continuity vs. distance as determined by three different methods.

Another interesting observation from the averages of these many pressure-transient tests is the relative lack of fractures in the producing wells even though all wells were stimulated by acid fracturing on initial completion. On the other hand, the producing wells are not damaged either, indicating mostly effective completions in the wells tested. Despite injection slightly below the fracture pressure, nearly all injectors indicate good stimulation and some fracture. It is unknown whether this results from some zones fracturing at lower-than-indicated fracture pressure or from some leaching of the carbonate by the freshwater injection, giving a fracture-like appearance on the pressure transient.

The concept of widely varying pressures in individual stringers is supported by data from wireline formation pressure tests. These tests were run in eight new infill wells from 1981 to 1984, with pressures successfully measured in more than 50 separate intervals. These pressures ranged from 644 to 4,136 psig [4.4 to 28.5 MPa]. The pressure distribution in each wellbore was random between intervals, and only rarely would two pressures fall on a hydrostatic gradient line, which would indicate that the zones were in vertical communication.

In the intervals tested, some zones appeared to be pressure-supported. The average pressures in the supported zones were 3,430 psig [23.6 MPa] in the north/sough offset wells and 3,580 psig [24.7 MPa] in the east/west wells. These agree reasonable well with the 3,450-psig [23.8 MPa] pressure calculated in Fig. 11.

Infill Productivity Experience

Table 2 lists the results of a study in which the production history of each well was extrapolated to an estimated economic limit. These results were then averaged to yield the estimated ultimate recovery, called "through-the-wellbore" in Table 2, for each of the various types of infill wells. A total of 218 wells is represented in this table, and the incremental through-the-wellbore production is about 24 million bbl [$3.8x10^6$ m^3]. Col. 4 is the result of detailed calculations of interference, on existing wells, from production of the new infills. This study determined that 95% of the through-the-wellbore recovery of an infill well is incremental capture or unique oil. This analysis is subjective, and at RCU it was complicated further by response from conversion of additional wells to injection service during the program. As discussed later, however, it is believed to be reasonably accurate.

TABLE 2 -- RCU INFILL DRILLING PROGRAM RESULTS

Type of Well	Number of Wells	Average Estimated Ultimate Recovery Per Well: Through Wellbore Estimated Ultimate Recovery (1,000 bbl)	Average Estimated Ultimate Recovery Per Well: Most Likely Capture Estimated Ultimate Recovery (1,000 bbl)
20-acre	83	166	158
North/south offsets	56	92	87
East/west offsets	58	70	67
Irregular or edge	21	78	74
Total for all wells	218	24,600	23,400

Another approach to estimate the incremental capture resulting from the infill wells is to compare the total field estimated ultimate recovery to that predicted before any infill drilling, in this case by the 1975-76 RCU study. This study, which used existing wellbores, predicted an ultimate recovery of 22 million bbl [3.5 x 10^6 m^3] by primary and 8 million bbl [1.3 x 10^6 m^3] by secondary, for a total of 30 million bbl [4.8 x 10^6 m^3] by existing operations. The study further estimated that improvements to current operations in the existing wellbores, primarily perforating and stimulating additional intervals, could improve ultimate recovery by as much as 12 million bbl [1.9 x 10^6 m^3]. This would yield a total recovery of 42 million bbl [6.7 x 10^6 m^3] from existing 40-acre [16-ha] wells. In hindsight, this figure was probably a maximum, if not slightly optimistic. The current estimate for ultimate recovery from the total unit is between 64 and 65 million bbl [10.2 x 10^6 and 10.3 x 10^6 m^3]. This would attribute 22 to 23 million bbl [3.5 x 10^6 to 3.7 x 10^6 m^3] to the total of 218 new of infill wells plus the results of injection-well conversions. The value of 23 million bbl [3.65 x 10^6 m^3] is within the accuracy of the 23.4 million bbl [3.72 x 10^6 m^3] shown as the most likely capture in Table 2.

Barber et al.[5] predicted that at least 79% of the through-the-wellbore recoveries would be incremental capture. They had predicted that a total of one hundred and seven 20-acre [8-ha] wells would yield an incremental capture of 10.7 million bbl [1.7 x 10^6 m^3]. More recent data, as well as the results from about 100 additional infill wells, have shown that this estimate was indeed pessimistic. Incremental capture is now estimated to be between 90 and 95% of through-the-wellbore production.

Correlations of Infill Performance to Reservoir Quality

Good infill performance can result from either unusually poor reservoir continuity in a local area or better-than-average reservoir deliverability and quality. The very good infill results at RCU would be consistent with the hypothesis that the reservoir was unusually discontinuous in some areas. The technique used to test this hypothesis involved mapping the performance of various wells, as measured by the individual well estimated ultimate recoveries. Figs. 13 through 16 show areas of better-than-average well performance by well type, 40-acre [16-ha], 20-acre [8-ha], north/south, or east/west offset infill wells. These figures show that the good 30-acre [8-ha] wells were located in the same areas as good original 40-acre [16-ha] wells. Similarly, good 10-acre [4-ha] wells are found in the same area. This coincides roughly with areas of better-than-average net pay thickness. The ratio of net pay thickness inside the good area to that in the outside area is not quite as great as the ratio of well estimated ultimate recovery performance inside the good area to other areas. This indicates that in addition to thicker net pay in this area of the field, the reservoir quality and deliverability are also better.

Fig. 13
Area of above average 40 acre producers (estimated ultimate recovery > 450,000 bbl/well).

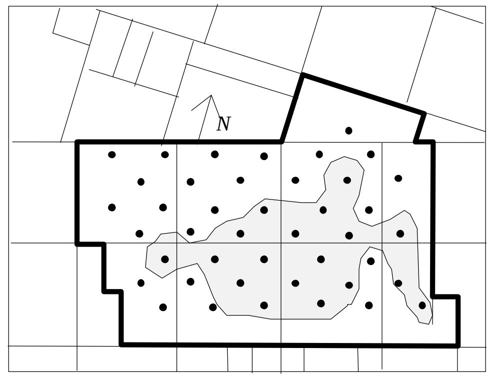


Fig. 14
Area of above average 20 acre producers (estimated ultimate recovery > 166,000 bbl/well).

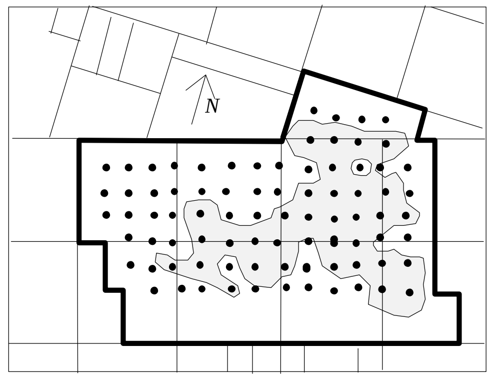


Fig. 15
Area of above average north/south offset producers (estimated ultimate recovery > 92,000 bbl/well).

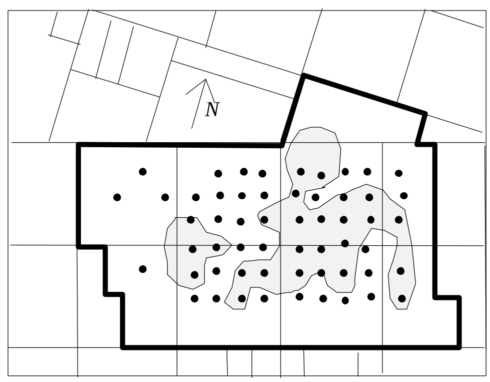


Fig. 16
Area of above average east/west producers (estimated ultimate recovery > 67,000 bbl/well).

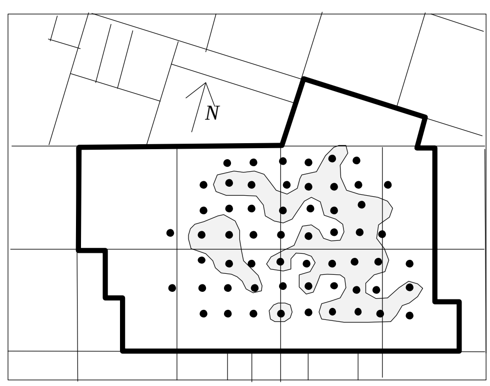


Table 3 compares the ratio of individual infill well estimated ultimate recovery performance to the estimated ultimate recoveries of its offsets. Four 40-acre [16-ha] wells surrounding each 20-acre [8-ha] infill were averaged and ratioed vs. the 20-acre [8-ha] estimated ultimate recovery. Each 10-acre [4-ha] well is offset by two 20-acre [8-ha] wells and by two 40-acre [16-ha] wells. These were averaged separately for the ratios. These ratios can be used to estimate recovery from additional locations that have not yet been drilled.

TABLE 3
COMPARISON OF THROUGH-THE-WELLBORE ESTIMATED ULTIMATE RECOVERIES

Type of Wellbores Compared	Average Estimated Ultimate Recovery Ratio (Infill vs. Older Wells)
20-acre well to average 40-acre direct offset	0.44
North/south 10-acre well to average 40-acre direct offset	0.23
North/south 10-acre well to average 20-acre direct offset	0.50
East/west 10-acre well to average 40-acre direct offset	0.18
East/west 10-acre well to average 20-acre direct offset	0.38

Numerical Analyses of Produced Volumes

A third approach to quantitative analysis of infill performance and reservoir continuity involved a modified nonlinear regression on the performance data. For this analysis, *drainable* describes the reservoir volume that can be drained to a wellbore by solution gas drive, and *floodable* describes the reservoir volume sufficiently continuous to be waterflooded between at least one injector/producer pair.

By use of the definitions for A, B, C, D, and F_p as shown in the Nomenclature, recoveries for wells within the area of 10-acre [4-ha] development are as follows.

1. Primary per 40-acre [16-ha] well is A+B+C+D.
2. Secondary per 40 acre [16-ha] well if F_p(A).
3. Primary per 20-acre [8-ha] well is C+D.
4. Secondary per 20-acre [8-ha] is F_p(B).
5. Total per 20-acre [8-ha] well is F_p(B)+C+D.
6. Primary per 10-acre [4-ha] well is D.
7. Secondary per 10-acre [4-ha] well is F_p(C).
8. Total per 10-acre [4-ha] well is F_p(C)+D.

Although continuity is really a measure of reservoir PV, for simplicity, A, B, C, and D are defined in terms of primary recovery--i.e., a constant recovery factor times the affected PV.

In the area of the field fully developed on 10-acre [4-ha] spacing, the actual well recoveries are listed in Table 4. (This area is shown in Fig. 17.) The "nominal" value represents the through-the-wellbore recoveries. The range is intended to account for drainage into or away from the well because of interference with other wells.

TABLE 4
ACTUAL WELL RECOVERIES FOR A FULLY DEVELOPED 10-ACRE SPACING

	------------ Average Recovery (1,000 bbl) ------------		
Well Type and Mode	Nominal	Range	Most Likely
40-acre primary			
40-acre secondary			
20-acre total			
10-acre total			

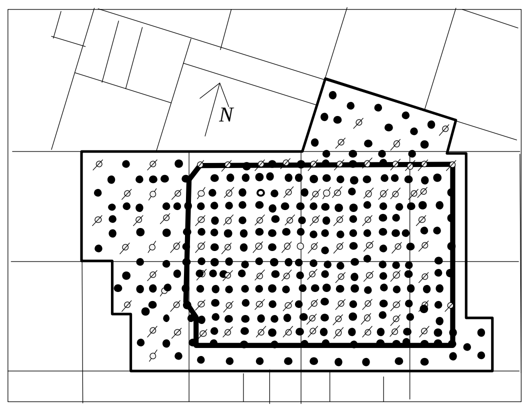


Fig. 17
RCU base map with area of 10-acre/well development highlighted.

The most likely values are based on estimates for the following.

1. Some primary recoverable oil for 40-acre [16-ha] wells was drained to infill wells and/or misallocated to the secondary project.
2. Secondary production (40 acres [16 ha] is essentially nominal because minor drainage to infill wells would more or less balance a possible misallocation of primary to secondary in allocating the well's estimated ultimate recovery.
3. The 20-and 10-acre [8- and 4-ha] wells produced oil that could eventually have been produced by the 40-acre [16-ha] wells.

Although the equations given earlier contain five unknowns, they can be solved approximately because of the requirement for all variables to be positive. If the most like parameters are used, A, B, C, and D are positive only for a range of F_p between 1.39 and 1.43, with a most reasonable value of 1.395. Throughout the range of parameters, F_p could vary between 1.3 and 1.55, but the most reasonable value of 1.395 is stable within likely perturbations of the most likely value.

The derived values for A, B, C, D, and F_p can be related to reservoir continuity in two ways. The first involves comparison of recoveries, by well type and mode, with the volumetrically calculated OOIP for an average 40-acre [16-ha] tract. Estimates of continuity in this case range up to 80%. Continuity estimates for various spacings are listed in Table 5. The detailed calculations are in the Appendix.

TABLE 5
RESERVOIR CONTINUITY BY NUMERICAL ANALYSES

Spacing	Reservoir Drainable by Solution Gas Drive	Reservoir Floodable Between at Least 2 Wells
(acres/well)	(%)	(%)
40	56	27
20	70	43
10	80	60

The second correlation is based on the assumption that ratios of actual primary and secondary recovery factors to the theoretical factors equal the continuity fractions for the field spacing. For 10-acre [4-ha] spacing, this analysis yields values of 87 and 63% for drainable and floodable fractions, respectively (see the Appendix for details).

Conclusions

1. Infill drilling has been a successful program at RCU, both on spacings of 20 acres [8-ha] per well and further infilling to 10 acres [4-ha] per well.

2. At RCU, with 10-acre [4-ha] spacing, about 80 to 85% of the reservoir PV is drainable by solution gas drive; with 40-acre [16-ha] inverted nine-spot patterns, about 60% is floodable between at least two wells.

3. The apparent difference in extrapolated transient pressures between producing wells and injection wells is a direct and correlatable function of the discontinuity between wells.

4. Pressure correlations, numerical analysis, and finely detailed geologic correlations have all been used successfully to quantify the degree of discontinuity in the reservoir formation at RCU.

5. Discontinuity must be considered in the design, planning, and operation of any EOR project because of the relatively large volumes of pay that cannot be flooded.

6. There is a preferential water movement at RCU in the east/west direction, either as a result of fracturing in the reservoir or from an in-situ directional permeability.

Nomenclature

A = primary recovery from that fraction of reservoir that could be floodable on 40-acre [16-ha] spacing, bbl [m^3]
B = primary recovery from that fraction of reservoir that is drainable on 40-acre [16-ha] spacing but floodable only on 20-acre [8-ha] spacing, [m^3]
C = primary recovery from that fraction of reservoir that is drainable on 20-acre [8-ha] spacing but floodable only with 10-acre [4-ha] spacing, bbl [m^3]
D = primary recovery from that fraction of reservoir that is drainable only on 10-acre [4-ha] spacing but not floodable on 10-acre [4-ha] spacing, bbl [m^3]
F_p = ratio of secondary to primary production from the portion of reservoir that is effectively waterflooded.

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Appendix--Waterflood Recovery Estimate for Floodable Reservoir

Robertson reservoir parameters include the following.

Dykstra-Parsons coefficient = 0.833.
Mobility ratio = 0.96.
Gas Saturation at flood start = 0.13 (in drained areas).
Water viscosity = 0.6 cp [0.6 mPa·s].
Oil viscosity at flood start = 1.17 cp [1.17 mPa·s].
Initial oil saturation = 0.708
residual oil saturation = 0.34.

With these parameters, waterflood conformance can be estimated by use of Staggs and Bilhartz's technique[6] to sweep 73% of the floodable volume. Assuming that oil resaturates 50% of the "unswept" gas saturation (an approximation based on other detailed waterflood studies in west Texas carbonates), the calculated ultimate recovery from the floodable portion of the formation is 31 to 32% of the OOIP.

As discussed in the Numerical Analysis of Produced Volumes section, the ratio of secondary to primary production in the swept reservoir is 1.395. With this ratio, the primary and secondary recovery factors are estimated at 13.2 and 18.3% of OOIP, respectively.

In the 10-acre [4-ha] infill area at RCU, average OIP is 3.36 million STB [$0.53\text{x}10^6$ stock-tank m^3] per 40-acre [16-ha] tract. Theoretical primary and secondary recoveries, therefore, would be (3.36 million)x(13.2%)=$444\text{x}10^3$ bbl [$71\text{x}10^3$ m^3] and (3.36 million)x(18.3%)=$615\text{x}10^3$ bbl [$98\text{x}10^3$ m^3], respectively, if continuity were 100% throughout the reservoir.

The fraction of reservoir volume drainable or floodable on various spacings can then be estimated with the parameters derived by numerical analysis. The most likely parameters are

A = 118,000 bbl [$18.8\text{x}10^3$ m^3],
B = 72,000 bbl [$11.4\text{x}10^3$ m^3],
C = 38,000 bbl [$6.0\text{x}10^3$ m^3],
D = 22,000 bbl [$3.5\text{x}10^3$ m^3], and
F_p = 1.395.

The following calculations show the drainable or floodable reservoir volume for the various well spacings.

The 40-acre [16-ha] drainable fraction is

$$\frac{A+B+C+D}{444} = \frac{118+72+38+22}{444}$$
$$= 0.56$$

The 40-acre [16-ha] floodable fraction is

$$\frac{F_p(A)}{615} = \frac{1395(118)}{615}$$
$$= 0.27$$

The 20-acre [8-ha] drainable fraction is

$$\frac{A + B + 2C + 2D}{444} = \frac{118 + 72 + 2(38) + 2(22)}{444}$$
$$= 0.70$$

The 20-acre [8-ha] floodable fraction is

$$\frac{F_p(A + B)}{615} = \frac{1395(118 + 72)}{615}$$
$$= 0.43$$

The 10-acre [8-ha] drainable fraction is

$$\frac{A + B + 2C + 4D}{444} = \frac{118 + 72 + 2(38) + 4(22)}{444}$$
$$= 0.80$$

The 10-acre [8-ha] floodable fraction is

$$\frac{F_p(A + B + 2C)}{615} = \frac{1395(118 + 72 + 2(38))}{615}$$
$$= 0.60$$

The effective secondary-to-primary ratio for each 40-acre [16-ha] tract within the 10-acre [8-ha] infill area is

$$\frac{F_p\left(A + B + 2C\right)}{\left(A + B + 2C + 4D\right)} = 1.0$$

These are the actual recoveries for this area.

Total estimated ultimate recovery = 43.7 million STB [7.5x10^6 stock-tank m^3].
OOIP = 206 million STB [32.7x10^6 stock-tank m^3].

Actual recovery factor = $\frac{47.3}{206}$

$= 23\%.$

Actual primary recovery = $23\% \times \frac{1}{1+1}$

at 1:1 secondary / primary

$= 11.5\%$

Fraction drainable by primary = $\dfrac{11.5\%\ \text{actual primary recovery}}{13.2\%\ \text{theoretical primary recovery}} = 87\%$ drainable volume fraction.

Actual Secondary = $= 23\% \times \dfrac{1}{1+1}$ at 1:1 secondary / primary $= 11.5\%$

Floodable volume = $\dfrac{11.5\%\ \text{actual primary recovery}}{18.3\%\ \text{theoretical primary recovery}} = 63\%$ drainable volume fraction.

SI Metric Conversion Factors

acres	x	4.046 873	E-01	=	ha
bbl	x	1.589 873	E-01	=	m^3
cp	x	1.0*	E-03	=	Pa·s
ft	x	3.048*	E-01	=	m
psi	x	6.894 757	E-00	=	kPa

* Converstion factor is exact.

SPE 11023

Infill Drilling To Increase Reserves--
Actual Experience in Nine Fields in Texas, Oklahoma, and Illinois

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Summary

Evaluation of reservoir discontinuity has been used by industry to estimate potential oil recovery to be realized from infill drilling. That this method may underestimate the additional recovery potential is shown by continuity evaluation in a west Texas carbonate reservoir, as infill drilling progressed from 40-acre ($162x10^3$-m^2) wells to 20-acre ($81x10^3$-m^2) and eventually to 10-acre ($40,5x10^3$-m^2) wells.

Actual production history from infill drilling in nine fields, including carbonate and sandstone reservoirs, shows that additional oil recovery was realized by improving reservoir continuity with increased well density.

Introduction

One objective of an orderly field-development program is to determine the maximum well spacing that will effectively drain oil and gas reserves. While wide spacing has proved effective in many oilfield applications, there are a growing number of examples where infill drilling, combined with water-injection pattern modifications, has provided substantial additional oil reserves. This paper deals with such fields; Means, Fullerton, Robertson, IAB (Menielle Penn), Howard Glasscock, Dorward, and Sand Hills fields in west Texas, Hewitt field in southern Oklahoma, and Loudon field in Illinois. The paper will quantify the contribution to current production and the additional reserves attributable to this action, using data available through Oct. 1981. Infill drilling has continued in most of the fields. Also revealed by infill drilling is the fact that the west Texas carbonate reservoirs are more stratified, and porous stringers are more discontinuous than revealed by initial studies.

Background

The theoretical concepts indicating that infill drilling will increase reservoir continuity and improve waterflood pattern conformance in heterogeneous west Texas carbonate reservoirs were researched and published in the early 1970's by Ghauri,[1] Ghauri et al.,[2] Stiles,[3] George,[4] and Driscoll.[5]

Detailed field studies recommending infill-drilling and waterflood-pattern modifications were made for the Means, Fullerton, and Robertson fields by Stiles and George.[3,4] Unpublished studies were made for the other reservoirs prior to infill drilling.

Borrowed from a previous work by George and Stiles,[4] Fig. 1 is a type cross section in the Fullerton Clearfork reservoir that illustrates the concept of "continuity," the percentage of pay in a well that is continuous to another well. The two original Wells A and B are 40-acre ($162x10^3$-m^2) locations, and the center well is an infill location 660 ft (201.2 m) from either original well. Note the discontinuous nature of the porosity stringers and that correlation before the infill well was drilled would have been considerably different than it is after the infill well was drilled. The increase in net pay in the infill well, especially in the upper part of the Clearfork formation, illustrates the fact that the more wells that are drilled, the more highly stratified, discontinuous, and complex a given west Texas carbonate reservoir is found to be. This fact leads to a conservative evaluation of the potential increased recovery from an infill well.

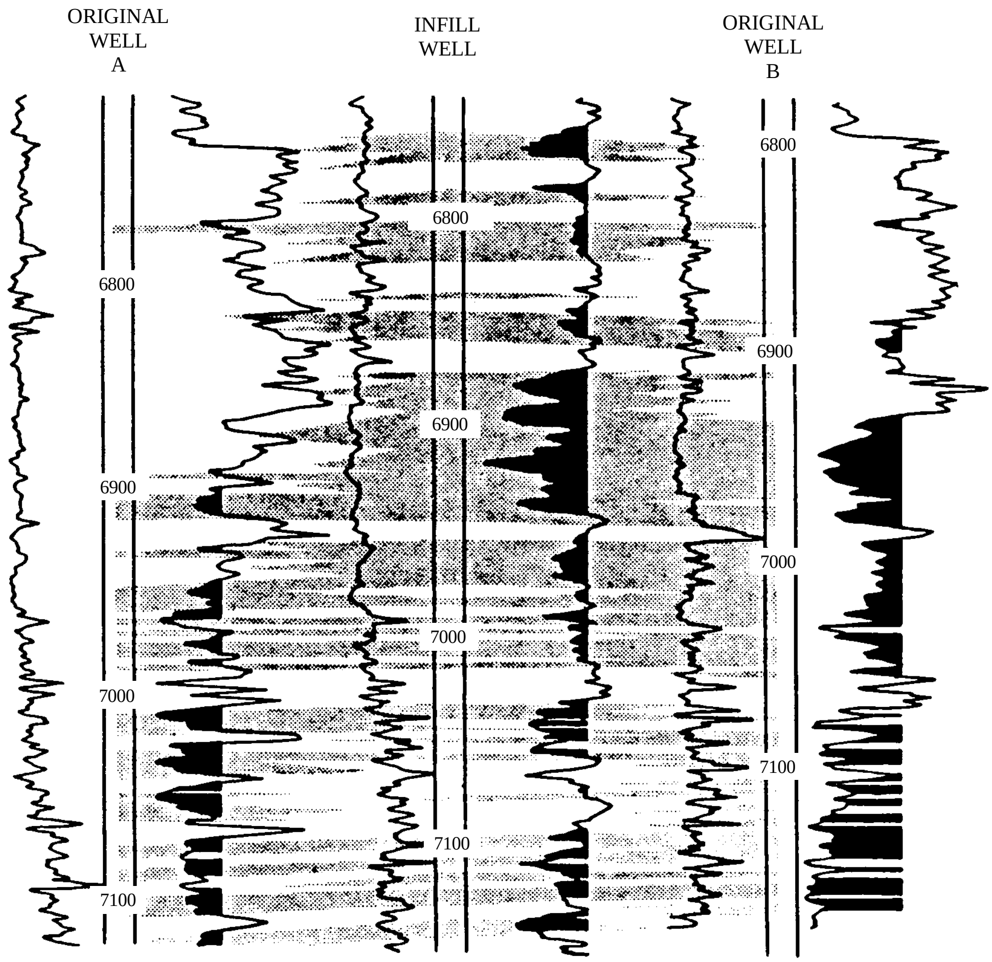

Fig. 1 -- Type cross section --Fullerton Clearfork reservoir (adapted from Ref. 4).

Considerations in Infill Drilling

A progression of continuity improvement was revealed by infill drilling in the Means San Andres field. Fig. 2 is a statistical plot of continuous pay vs. horizontal distance between wells for an area at Means that has been infill drilled to 10-acre ($40.5x10^3$-m^2) density. This technique was used by Shell Oil Co.[6] and was discussed by Stiles[3] in a previous paper. The top curve, made prior to infill drilling, shows the increase in apparent continuity between wells with increasing well density. Subsequent curves, made after infill drilling, show the pay development to be more discontinuous than would have been predicted. As shown by the upper curve, based on 40-acre ($162x10^3$-m^2) wells alone, an increase in continuity of 3% would be expected as spacing decreased from 20 acres ($81x10^3m^2$) to 10 acres ($40.5x10^3m^2$). The second curve, after 20-acre ($81x10^3$-m^2) wells were drilled. shows that with only 40-acre ($162x10^3$-m^2) and 20-acre ($81x10^3$-m^2) wells, an increase in continuity of 4% would be anticipated as spacing decreased from 20 acres ($81x10^3m^2$) to 10 acres ($40.5x10^3$ m^2). The analysis including the 10-acre ($40.5x10^3$-m^2) wells, shown by the lower line, indicates an apparent 14% improvement in continuity. The absolute values obtained for this particular area of the field are not necessarily typical of what would be expected throughout the field but do illustrate the concept of progressive increase in continuity with closer well spacing.

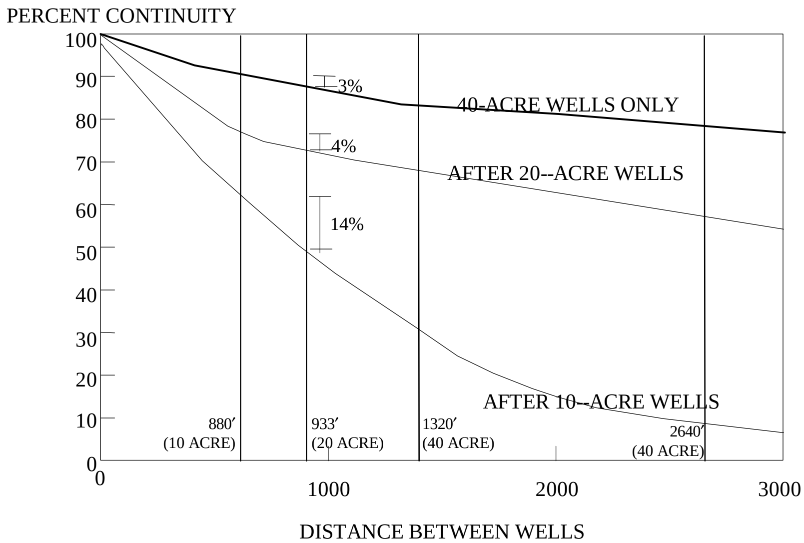

Fig. 2 -- Continuity progression -- San Andres Unit.

The complexity of stringerization is even more obvious after Fig. 3 is examined. This is a cross section through three wells in a tertiary pilot in the Means San Andres reservoir. The wells are located approximately 150 ft (45.7 m) apart, and core porosity and permeability have been correlated over the same stratigraphic interval. Porosity is plotted to the left and permeability is plotted on a log scale to the right. The pay intervals are relatively continuous between wells, but the porosity variations are significant in an individual stringer between wells. Permeability variations are even more severe. With injected fluids taking the path of least resistance, this plot serves to illustrate why, even in stringers that are continuous between wells, recovery may be lower than anticipated.

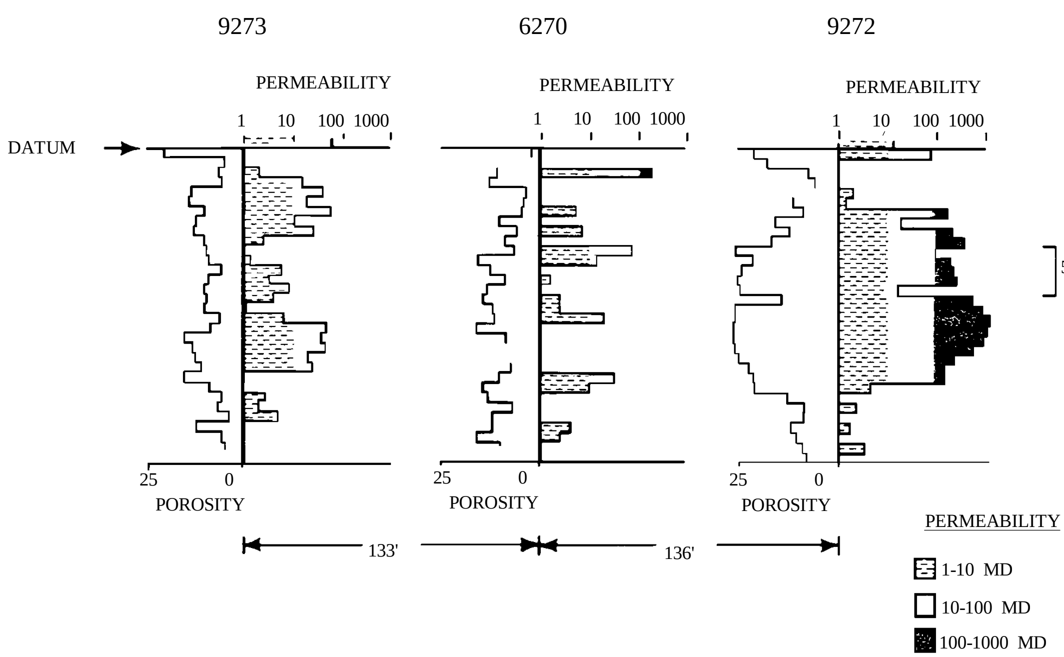

Fig. 3 -- Porosity and permeability variations--Means tertiary pilot.

In a previous paper,[3] it was stated that a pay interval must meet the following three requirements for waterflooding.

1. It must be continuous and reasonable homogeneous between an injection well and the offset producing wells.
2. It must be injection supported.
3. It must be effectively completed in the offset producing well.

In many west Texas Permian carbonate reservoirs there may be 50 or more individual pay stringers. Only rarely will all the stringers be effectively completed in a specific well. When a pay stringer is not effectively completed in a given well, a partial pattern exists for that stringer, and recovery will be less than for a complete pattern. These considerations were used to evaluate infill drilling and pattern modifications in several fields.

Infill Drilling Results

Major infill drilling programs were implemented in nine fields in west Texas, Oklahoma, and Illinois. These fields include dolomite, limestone, and sandstone reservoirs with porosities varying from 4 to 21% and with average permeabilities varying from 0.65 to about 184 md. Two of the fields are still on primary production, the other seven are waterflood fields. A detailed discussion of each of these fields follows.

Means San Andres Unit

One of the first field studied was the Means San Andres reservoir in Andrews County, TX. Production is from a depth of 4,400 ft (1341 m). The San Andres is over 1,400 ft (427 m) thick, but only the upper 200 to 300 ft (61 to 91 m) is productive at Means. It is predominantly dolomite with minor shale and anhydrite. Average porosity and permeability are 9% and 20 md, respectively. Oil viscosity was 6 cp 6 mPa·s) at initial reservoir conditions. The reservoir was discovered in 1934 and drilled to 40-acre ($162x10^3$-m^2) spacing. Waterflooding began in 1963 with a peripheral pattern, which was expanded to a three-to-one line drive in 1970. Following a detailed reservoir study in 1975, a large-scale infill-drilling and pattern-modification program was begun. By the 1981 study cutoff date, 141 twenty-acre ($81x10^3$-m^2) and 16 ten-acre ($40.5x10^3$-m^2) infill wells had been drilled. During this period the pattern was gradually changed. Generally to an 80-acre ($324x10^3$-m^2) inverted nine-spot.

Actual production from the 40-acre acre ($162x10^3$-m^2) wells is shown by the lower line in Fig. 4. Production from the total unit is shown by the upper line. The area between these lines is wellbore oil production from the infill wells. The area between the dashed line and actual 40-acre acre ($162x10^3$-m^2) well production is interference oil. Increased recovery resulting from infill drilling is that production represented by the area between the dashed line and the total unit production. The infill wells account for 68% of the unit daily production.

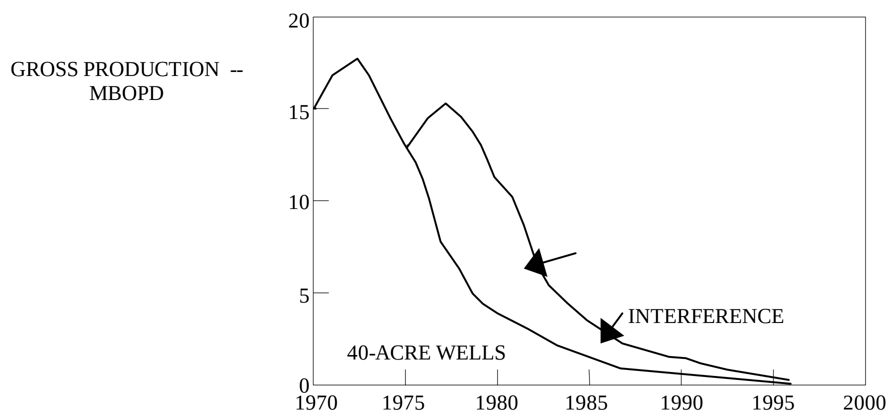

Fig. 4 -- Production datagraph--Means San Andres Unit.

Increased recovery is calculated to be 15.4 million bbl acre ($2.4x10^6$ m^3) oil, or 66% of the total oil produced by the infill wells. The unit was divided into 40-acre acre ($162x10^3$-m^2) tracts and the original oil in place (OOIP) was calculated volumetrically for each of these tracts.[4] Additional recovery was calculated for each infill well, and as to be expected, the recoveries varied widely. In general, the additional recovery for the 20-acre acre ($81x10^3$-m^2) infill wells ranged from 5 to 8% OOIP in the 40-acre acre ($162x10^3$-m^2) tract in which the infill well was drilled.

In a smaller area in the Means field sixteen 10-acre acre ($40.5x10^3$-m^2) wells were drilled in the two pilot areas in 1979 and 1980. Fig. 5 shows the impact of the 10-acre acre ($40.5x10^3$-m^2) infills on the production in the pilot areas. Decline-curve analysis indicates that additional recovery from the 10-acre ($40.5x10^3$-m^2) infills will be 1.2 million bbl ($1.9x10^5$ m^3) oil, or 67% of the wellbore recovery. Additional recovery from the 10-acre ($40.5x10^3$-m^2) infill wells is estimated to vary from 2 to 5% OOIP in the 40-acre ($162x10^3$-m^2) tract in which the infill well was drilled.

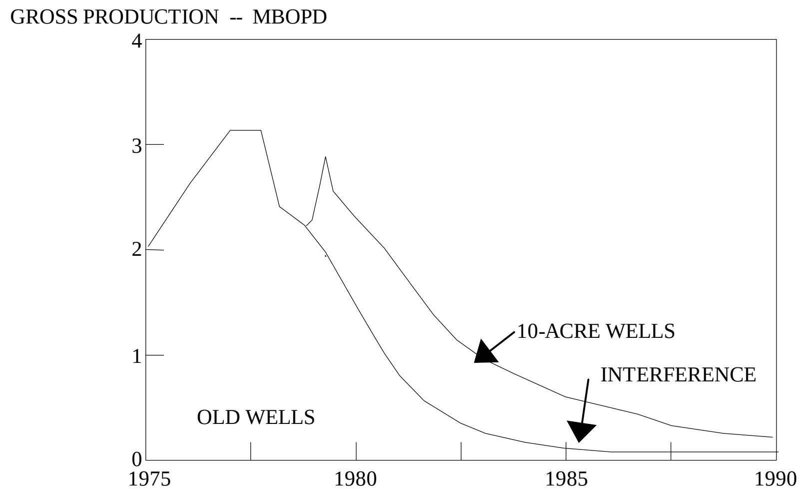

Fig. 5 -- Production datagraph--10-acre pilot, Means San Andres Unit.

Fullerton Field

The Fullerton Clearfork Unit, also located in Andrews County, TX, produces from the Permian Clearfork and Wichita formations, which are predominantly dolomite interbedded with limestone, anhydrite, and shale. Production is from an average depth of 7,000 ft (2134 m), and the reservoir averages 10% porosity and 3-md permeability. At initial reservoir conditions, the oil viscosity was 0.75 cp (0.75 mPa·s).

Fullerton was discovered in 1942 and was originally developed on 40-acre ($162x10^3$-m^2) spacing. The Fullerton Clearfork Unit has been under water injection since 1961. The original pattern used in the largest portion of the field, the North dome, was a three-to-one line drive, with the injectors oriented north-south. The original north-south injection rows are shown in Fig. 6. Note the 80 acres ($324x10^3$ m^2) outlined by the dashed line. An 80-acre ($324x10^3$-m^2) tract in this position will be discussed further.

Based on the recommendations of a 1973 study reported by Stiles,[3] a program later called the phase I infill program was initiated. Under this program, the wells shown by the solid dots in Fig. 6 were drilled as infill producers, and half the adjacent row producers were converted to injection wells as shown by the solid triangles. Sixty-one Phase I wells were drilled. At the conclusion of the Phase I drilling in 1976, the average production of the Phase I wells was 88 B/D (14 m^3/d) oil with a 46% water cut. Average production for the offset wells was about half, or 46 B/D (7.3 m^3/d) oil, with a 68% water cut. The fact that these infill wells performed better than the offsets indicated that additional pay was being opened up, which in turn implied that less than all the pay was being flooded.

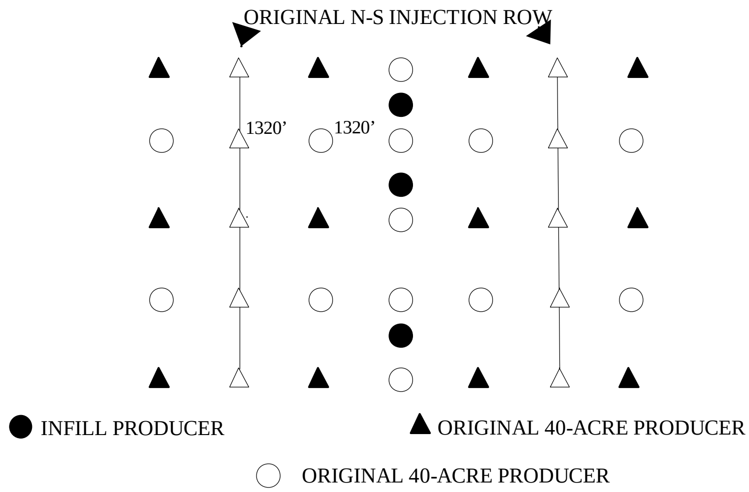

Fig. 6 -- Phase 1 infill drilling -- Fullerton Clearfork Unit.

An 80-acre (324 x 10^3-m^2) tract, outlined in Fig. 6, has been enlarged and is shown in Fig. 7. The original north-south injection row is to the left and the black dot to the right fixes the location of the 61 Phase I wells. The solid triangle shows the location of the Phase I injection conversion. Prior to Phase I program, seven wells had been drilled between 1970 and 1972 in the positions shown by the hexagons. These wells had average initial potentials of 221 B/D (35.1 m^3/d) oil, and in July 1976 they were producing an average of 92 B/D (14.6 m^3 /d) oil and 70% water. Their offset wells were producing an average of 26 B/D (4.1 m^3 /d) oil. The performance of the Phase I wells and the seven earlier wells suggested that additional recovery might be obtained if wells were drilled anywhere within the pattern. In 1976, three wells were drilled in the position shown by the square. They produced an average of 115 B/D (18.3 m^3 /d) oil with a 74 % water cut. Four of the six direct offsets to these wells had been shut in from 4 to 9 years earlier as uneconomical to produce. One was a producer testing 1 B/D (0.16 m^3 /d) oil and 500 B/D (79.5 m^3 /d) water. The sixth was an injector that had been converted in 1975 while producing 38 B/D (6 m^3 /d) oil.

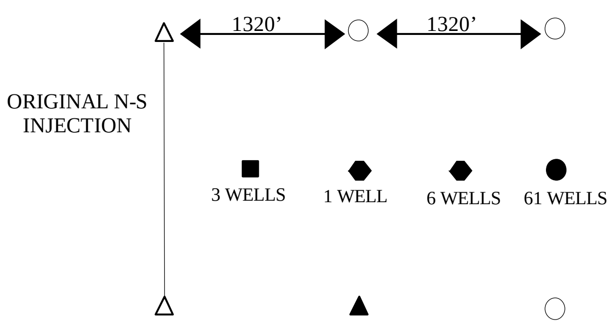

Fig. 7 -- Pilot infill drilling -- Fullerton Clearfork Unit.

As a result of these 10 pilot wells, a 151-well Phase II infill drilling program at Fullerton was undertaken. Phase II wells have been drilled in the position shown by the square in Fig. 8. Wells in the position captioned "Phase II Conversion" are being converted to injection as part of the Phase II program. Of the 171 wells in this conversion location, 111 were watered out by 1976. Most others were producing at very low rates. It can be concluded that Phase II wells are mostly additional recovery. The production contribution from these infill drilling programs can be seen in Fig. 9. This datagraph shows the impact of the Phase I, Phase II, and other infill wells. These wells account for 71% of the unit's current production and will result in additional recovery of 24.6 million bbl (3.9x10^6 m^3) oil. Fifty-six percent of the wellbore reserves are increased recovery and will average about 97,000 bbl (15.4x10^3 m^3) per infill well.

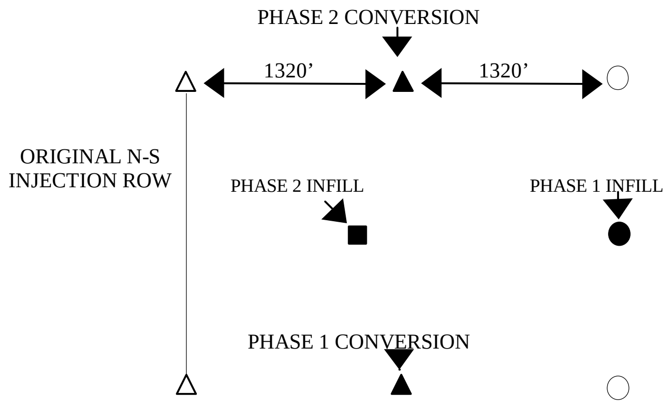

Fig. 8 -- Phase 2 infill drilling -- Fullerton Clearfork Unit.

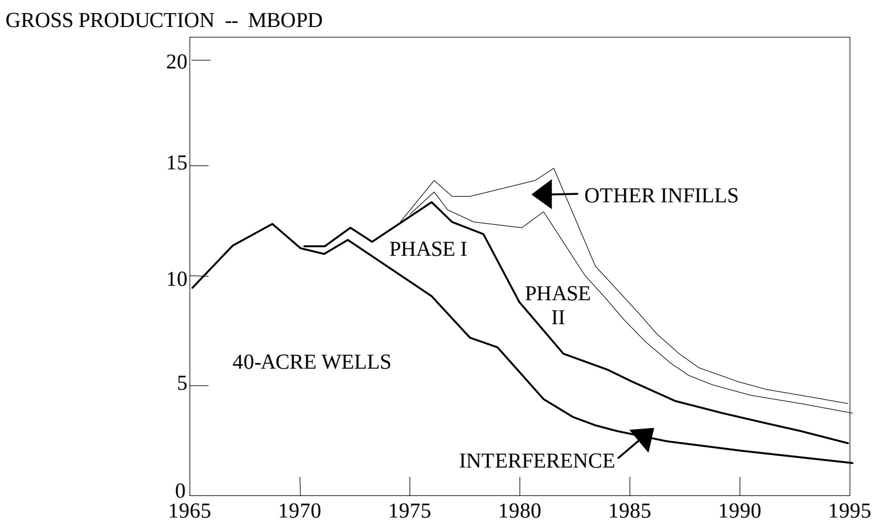

Fig. 9 -- Production datagraph --Fullerton Clearfork.

Robertson Field

The Robertson Clearfork Unit in Gaines County, TX, produces from the Permian Glorieta, Upper Clearfork, and Lower Clearfork formations, at an average depth of 6,500 ft (1981 m). The reservoir is about 1,400 ft (427 m) thick with actual net pay of about 200 to 300 ft (61 to 91 m), broken vertically into as many as 50 to 60 separate porosity stringers in any given well. Fig 10, a cross section between two 40-acre ($162x10^3$-m^2) wells, better illustrates the extreme stringerization. The reservoir rock is predominantly dolomite with anhydrite and shale. Porosity averages 6.3% and permeability averages 0.65 md. Oil viscosity at reservoir conditions is 1.2 cp (1.2 mPa·s). Beginning in 1942, the area was drilled on 40-acre ($162x10^3$-m^2) locations. In 1969, the unit was formed for water flooding. From 1976 through 1980, 107 infill wells were drilled on 20-acre ($81x10^3$-m^2) spacing. A 10-acre ($40.5x10^3$-m^2) drilling program has begun with 31 wells completed through Oct. 1981.

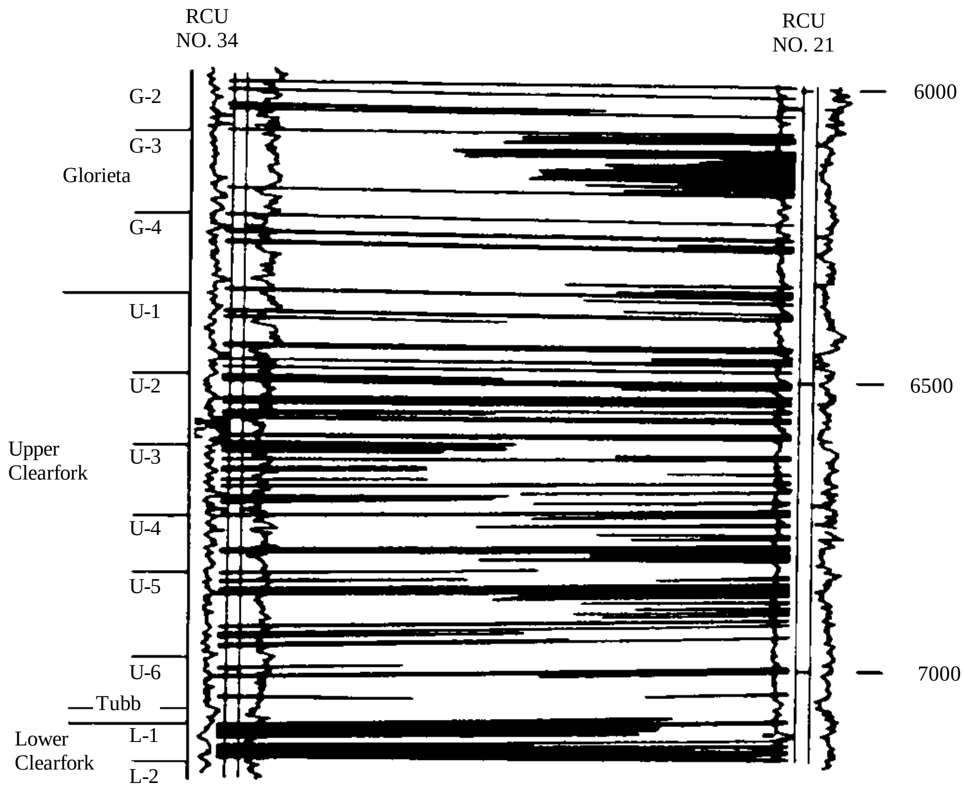

Fig. 10 -- Cross section -- Robertson Clearfork Unit.

The contribution of the 20-acre ($81x10^3$-m^2) and 10-acre ($40.5x10^3$-m^2) wells is shown in Fig. 11. The dashed line represents the expected production from the 40-acre ($162x10^3$-m^2) wells had there been no infills. Infill wells provide 73% of the current production. They are expected to add additional reserves of 10.7 million bbl ($1.7x10^6$ m^3). Increased recovery represents 79% of the wellbore reserves and is about 73,000 bbl ($11.6x10^3$ m^3) per well.

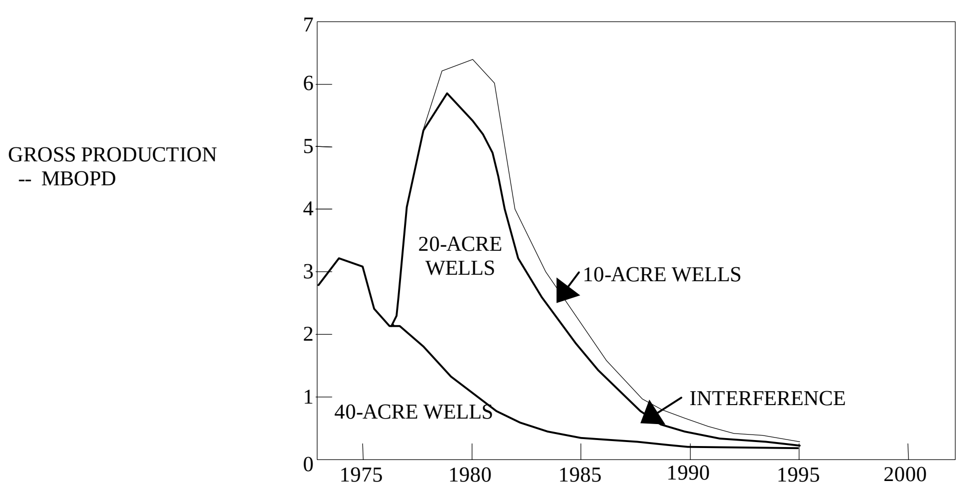

Fig. 11 -- Production datagraph -- Robertson Clearfork Unit.

IAB Field

The IAB (Menielle Penn) field is located in Coke County, TX. The Menielle Penn reservoir produces from a depth of 5,800 ft (1768 m) and is a coarse skeletal limestone buildup with an average of 7% porosity and 27-md permeability. The oil viscosity at initial reservoir conditions was only 0.2 cp (0.2 mPa·s) at IAB. The reservoir was discovered in 1958 and was drilled initially on 80-acre ($324x10^3$-m^2) spacing. Waterflooding began in 1962 with an initial pattern which was essentially a three-to-one line drive. Fig. 12 is the production datagraph showing the impact from a 17-well 40-acre ($162x10^3$-m^2) infill drilling program that began in 1978. The dashed line is an extrapolation of what the 80-acre ($324x10^3$-m^2) wells would have done if the infill wells had not been drilled. The lower solid line shows the actual and forecasted performance of the old wells. This analysis shows that the infill wells will increase the field's reserves by 1.7 million bbl ($2.7x10^6$ m^3). This represents additional recovery of 100,000 bbl ($1.59x10^5$ m^3) per well, which is 58% of the wellbore reserves and 4% of OOIP in the affected area.

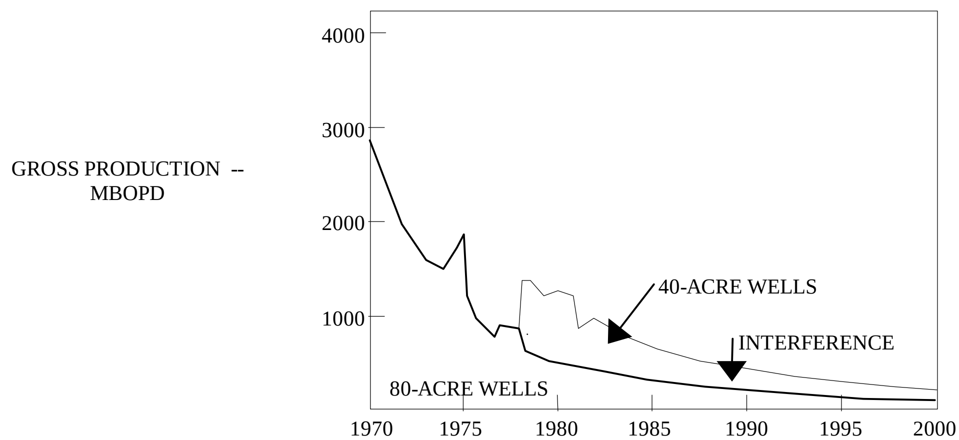

Fig. 12 -- Production datagraph -- IAB (Menielle Penn) Field.

Howard-Glasscock Field

The Douthit Unit, located in Howard and Sterling Counties, TX, was formed for waterflooding the Permian Seven Rivers reservoir in the Howard-Glasscock field. The reservoir is approximately 1,400 ft (427 m) deep and is a sandstone with a porosity of 18% and a permeability of 44 md. In this reservoir, the oil viscosity of 9.4 cp (9.4 mPa·s) is relatively high for west Texas reservoirs. Development of the Seven Rivers reservoir in this area began in 1957, and it was originally drilled on 40-acre ($162x10^3$-m^2) locations. Waterflooding began in 1968 with a peripheral injection pattern. Ten-acre ($40.5x10^3$-m^2) development began in 1976, and, by the 1981 study cutoff date, 52 infill wells had been drilled. The production datagraph, Fig. 13, shows the additional production from the infills along with production from the older wells. The infill wells account for 75% of the current production, and wellbore production is 88% additional recovery. Total additional recovery of 1.0 million bbl ($1.59x10^6$ m^3) is expected.

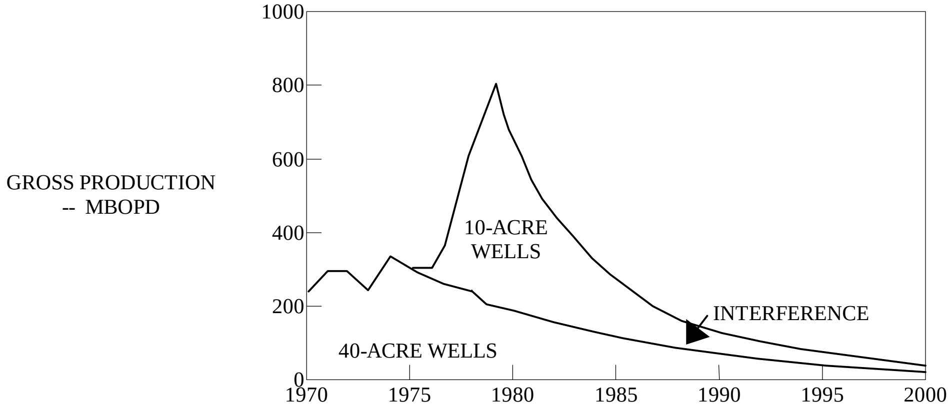

Fig. 13 -- Production datagraph -- Douthit Unit, Howard-Glasscock field.

Dorward Field

The Dorward field is located in Scurry and Garza Counties, TX. Production is commingled from the Permian San Angelo and San Andres formations at average depths of 2,350 and 2,100 ft (716 and 640 m), respectively. The San Angelo formation is mostly dolomite interbedded with shale and sandstone. The San Andres consists of dolomite, anhydrite, and shale. Apparent porosity for the San Angelo and San Andres are 15 and 13.5%, respectively. Actual porosities are probably less because of the presence of gypsum, which causes optimistic measurements of porosities in cores and logs. Average permeability is about 3 md in both reservoirs. In the San Angelo, the oil viscosity is 1.9 cp (1.9 mPa·s) while in the San Andres, it is 3.2 cp (3.2 mPa·s).

The field was discovered in 1950 and drilled on 40-acre ($162x10^3$-m^2) spacing. Although waterflooding began in 1958 in a portion of the field, most of the field has been and is currently producing primary oil by dissolved-gas drive. Peripheral and 80-acre ($324x10^3$-m^2) five-spot patterns were tried. Early water breakthrough, caused by directional permeability and severe stratification, discouraged expansion of waterflooding to other areas.

Infill drilling began in 1971. At that time, 149 wells on 40-acre ($162x10^3$-m^2) spacing had been drilled. An average of 49,400 bbl (7850 m^3) oil per well had been accumulated, and production had declined to an average of 4.8 B/D (0.76 m^3/d) oil per well for the 107 wells still producing at that time. From 1971 through 1980, there were 123 twenty-acre ($81x10^3$-m^2) infill wells drilled. Ten-acre ($40.5x10^3$-m^2) drilling began in 1979, and 17 wells had been drilled by the end of 1980. Fig. 14 shows the results.

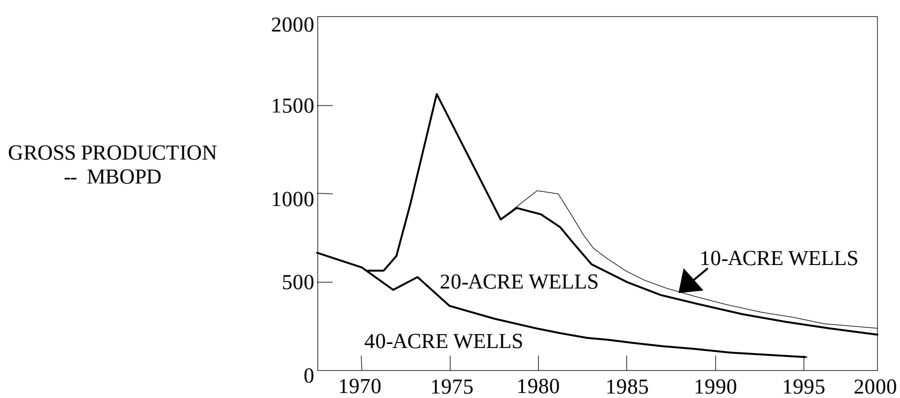

Fig. 14 -- Production datagraph --Dorward Field.

Because production was nearing the economic limit when infill drilling began, essentially all production from the infill wells is considered increased recovery. The infill wells will provide additional recovery of 4.6 million bbl ($7.3x10^5$ m^3) of oil or 33,000 bbl (5244 m^3) per well. The field is now being studied for further 10-acre ($40.5x10^3$-m^2) development and to determine if waterflooding is feasible with increased well density.

Sand Hills

Infill drilling in the Sand hills area of Crane County, TX has been concentrated in the Sand hills (Tubb and McKnight) fields. The Tubb reservoir produces from the Permian Lower Clearfork formation at a depth of 4,250 ft (1295 m) and is anhydritic dolomite with a minor amount of limestone. Average porosity and permeability are 4% and 12 md, respectively. Oil viscosity in the Tubb is 1.5 cp (1.5 mPa·s) at initial reservoir conditions. The McKnight reservoir produces from the Permian Lower San Andres at a depth of 3,200 ft (975 m) and is also mostly anhydritic dolomite. In this reservoir, average porosity and permeability are 5% and 1.3 md, respectively. In the McKnight reservoir, the oil viscosity is 1.0 cp (1.0 mPa·s). Gross productive interval is approximately 400 ft (122 m) in the Tubb and 350 ft (107 m) in the McKnight. Both reservoirs are highly stringerized with indications of poor reservoir continuity. They are both productive throughout the area of interest.

The Sand Hills (Tubb) field was discovered in 1931 and was generally developed on 40-acre ($162x10^3$-m^2) spacing. In the area of interest, most of the Tubb 40-acre ($162x10^3$-m^2) drilling was between 1936 and 1941. Development of the McKnight reservoir did not begin until 1955. McKnight development was erratic, depending largely on recompletions from the depleting Tubb reservoir; however, there was some drilling along with the workovers. Most of the 40-acre ($162x10^3$-m^2) McKnight activity was from 1955 to 1965 and later during the 1970's.

A 20-acre ($81x10^3$-m^2) infill program was begun in 1979. By the 1981 cutoff date, 56 infill wells had been drilled, with most of them being dually completed in both reservoirs. As expected, these wells found stringers that were pressure depleted but also found stringers that were only partially depleted or had not been penetrated by other wells. Forty-acre ($162x10^3$-m^2) development had continued until the time when the 20-acre ($81x10^3$-m^2) infill program began. Thus, a substantial amount of total production was flush production from recently drilled wells. Production from the older 40-acre ($162x10^3$-m^2) locations, those drilled before 1975, was 5.5 B/D (0.87 m^3/d) oil from the McKnight and 5.3 B/D (0.84 m^3/d) oil from the Tubb. Remaining reserves from these wells were about 9,000 bbl (1431 m^3) per well.

Fig. 15 shows both the performance of the 20-acre ($81x10^3$-m^2) infills and the offset 40-acre ($162x10^3$-m^2) wells, including the recently drilled ones. During 1981, the infills produced 45% of the total production. Performance to date indicates that will ultimately produce 1.6 million bbl ($2.5x10^5$ m^3) of additional oil or 28,400 bbl (4516 m^3) per well. This recovery compares favorably with the estimated remaining 9,000 bbl (1430 m^3) per well from the older 40-acre ($162x10^3$-m^2) wells. Because of the extreme lenticularity of these reservoirs and difficulty in obtaining reliable porosity data, good values for OOIP are not available.

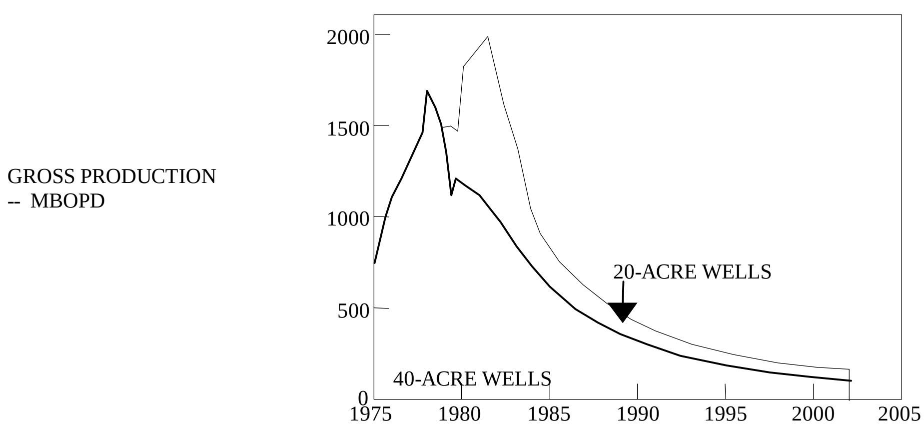

Fig. 15 -- Production datagraph --Sand Hills Area.

Hewitt Field

The Hewitt field, located in Carter County, OK, was discovered in 1919. Production is from 22 Pennsylvanian Hoxbar and Deese sand intervals, with a gross thickness of over 1,500 ft (457 m). The many sand intervals are separated by shale zones. Average depth to the top of the first pay interval is about 2,000 ft (610 m). The sands have an average porosity of 21% and an average permeability of 184 md. Oil viscosity in this reservoir is 8.7 cp (8.7 mPa·s). In the are of infill drilling, the original spacing was 2.5 acres ($10x10^3$-m^2). After the field was unitized for secondary recovery operations, many of the old wells were plugged and the field was redrilled on 10-acre ($40.5x10^3$-m^2) spacing. A fieldwide 20-acre ($81x10^3$-m^2) five-spot water injection project was begun.[7] Fifteen five-acre ($20x10^3$-m^2) infills have been drilled and their impact is shown in Fig. 16. The infills account for 23% of current unit production. Our analysis indicates about 60% of the wellbore reserves will be increased recovery and will total about 400,000 bbl ($6.4x10^4$ m^3) from the 15 wells.

The performance of the best well of these infills is a good example of the erratic nature of the porosity development and fluid-flow characteristics of this reservoir. This well potentialed for 414 B/D (65.8 m^3/d) oil with a 50% water cut, although one offset was producing 44 B/D (7.0 m^3/d) oil with a 96% water cut, and the other was producing only 7 B/D (1.1 m^3/d) oil with a 99% water cut. Overall project water cut is 97%. This type of result was obtained in a reservoir that was developed on 2.5-acre ($10x10^3$-m^2) spacing with a 20-acre ($81x10^3$-m^2) five-spot pattern.

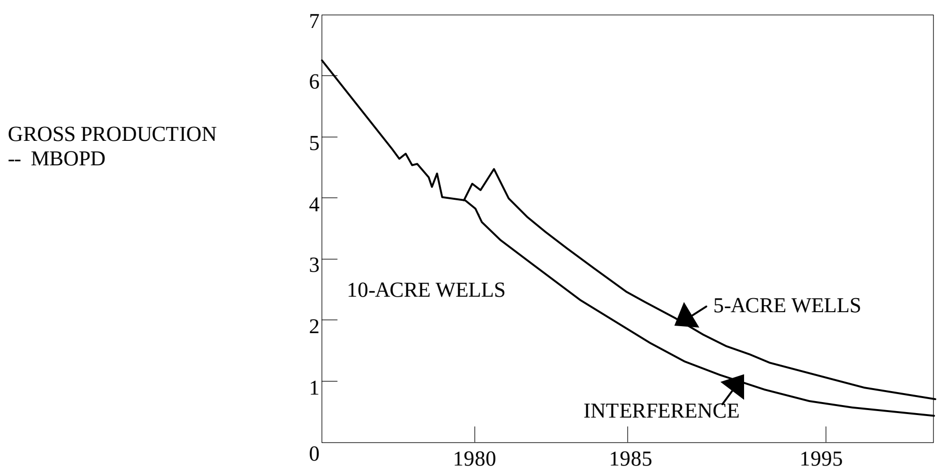

Fig. 16 -- Production datagraph -- Hewitt Unit, Hewitt Field (OK).

Loudon Field

The Loudon field, discovered in 1937, is located in Fayette and Effingham Counties, IL, and produces from four Mississippian sandstones, The Weiler, Paint Creek, Bethel, and Aux Vases, at an average depth of 1,500 ft (457 m). Average porosity is 19%, and average permeability is about 100 md. The oil viscosity is 5 cp (5 mPa·s). The northern half of the field was drilled on 20-acre ($81x10^3$-m^2) spacing in a sunflower pattern. The southern half of the field was drilled on 10-acre ($40.5x10^3$-m^2) spacing. Waterflooding began in the early 1950's, with the north half of the field on a 70-acre ($283x10^3$-m^2)nine-spot pattern and the south half on a 20-acre ($81x10^3$-m^2)five-spot pattern. Subsequently, injection wells were drilled in 10-acre ($40.5x10^3$-m^2) "dead" spots that are characteristic of the sunflower pattern, thus creating 10-acre ($40.5x10^3$-m^2) five-spot patterns. Producing water cut is now 98%.

Beginning in 1979, 50 infill wells have been drilled in the 20-acre($81x10^3$-m^2) development area. These infills were drilled at the intersection of a line between 20-acre ($81x10^3$-m^2) producing wells and a line connecting offset injection wells. This is a dead area in the flood pattern, and it was thought that these areas had been inadequately flooded. Initial production ranged from 131 B/D (20.8 m^3/d) oil to 3.4 B/D (0.54 m^3/d) oil, with the average being 25 B/D (4.0 m^3/d) oil. Offsets were producing less than 4 B/D (4.0 m^3/d) oil average prior to the drilling of the infill wells. Fig.

17 shows the impact of drilling these 50 infills. At the time of analysis these wells were producing about 600 B/D (95.4 m^3/d) oil or 18% of total field production.

Because of their location and the stage of depletion of the field, essentially all production from these wells is considered increased recovery. These infills are expected to increase oil reserves by 970,000 bbl (1.5x10^5 m^3).

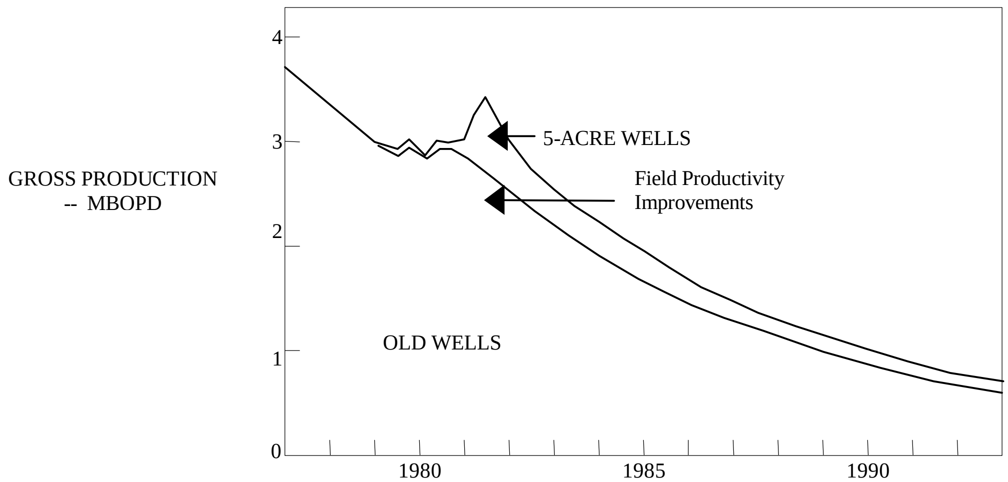

Fig. 17 -- Production datagraph -- Hewitt Unit, Hewitt Field (OK).

Conclusions

The conclusions formulated from this infill drilling study are as follows:

1. Infill drilling in nine fields has resulted in per-well-recovery improvements that are attractive under current economic conditions.
2. Increased oil recovery from the drilling of 870 infill wells in 9 fields ranges from 56% to 100% of their wellbore production.
3. Total additional reserves from these wells will be 60.8 million bbl (9.7x10^6 m^3) oil.
4. Continuity calculations made after infill drilling indicated the pay zones to be more discontinuous that when calculations were made before infill drilling.
5. The experience in these nine fields indicates that the ultimate well density in any given field can be determined only after several years of field performance provide sufficient information on reservoir continuity and recovery efficiencies.

Acknowledgments

We thank the many persons who made this paper possible by supplying data, preparing graphics, and typing the manuscript.

References

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5. Driscoll, V.J.: "Recovery Optimization Through Infill Drilling--Concepts, Analysis, and Field Results, "paper SPE 4977 presented at the 1974 SPE Annual Technical Conference and Exhibition, Houston, Oct. 6-9.
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SI Metric Conversion Factors

acre	x	4.946 873	E+03	=	m^2
bbl	x	1.589 873	E-01	=	m^3
ft	x	3.048*	E-01	=	m

* Conversion factor is exact.

APPENDIX 2b
IDPM INPUT/OUTPUT FOR IDPM VALIDATION AGAINST FIELD FLOOD RESULTS

```
                    S C I E N T I F I C   S O F T W A R E
                                 I N T E R C O M P

                       INFILL DRILLING PREDICTION MODEL
                            (IDPM - RELEASE 1.2.0)

IDPM DATA - VERSION 1.2:  Field Validation using Robertson Clearfork Unit
  IPDM DATA - VERSION 1.2:  Field Validation using Robertson Clearfork Unit
  0, 1, 1, 0, 0, 0.83
  2, 8, 15, 1, 0, 1
  80., 300.0, 1320., 0.55, 200., 450., .60, 0.90, 0.
  .000003, 3000., 3000., -06500., 117.
  64.00, 1.0001, .000003,   .6,   0.8
  32.00, 1.25, .00000735, 1.2, 300.
  2., 2., .8, .2, .3, .24, .
  1
  .063, .65, 250.

I D P M  CURRENT MAXIMUM PARAMETER VALUES

  NUMBER OF TUBES PER LAYER                    16
  NUMBER OF GRID CELLS PER TUBE                15
  NUMBER OF LAYERS                             20
  NUMBER OF TIMESTEPS IN RESERVOIR RUN       5000
  BLANK COMMON SIZE FOR RESERVOIR RUN       10000
  NUMBER OF YEARS FOR ECONOMIC ANALYSIS        50

SPECIFIED PRINTOUT CONTROLS

  RESERVOIR ARRAY OUTPUT CONTROL                0   IARRP
  RESERVOIR ANALYSIS OUTPUT CONTROL             1   IANALP
  STREAMTUBE OUTPUT CONTROL                     1   ISTRMP
  ECONOMIC ANALYSIS CONTROL (0-NO,  1-YES)      0   IECONR

RESERVOIR PROPERTIES OUTPUT

  FORMATION DEPTH -- SUBSURFACE             -6500.0   FEET
  FORMATION TEMPERATURE                       117.0   DEG F
  INDIVIDUAL PATTERN AREA                      80.0   ACRES
  KV/KH VERTICAL TO HORIZONTAL PERM           0.000
  KY/KX ANISOTROPIC VALUE (1.0-100.0)         1.000
  DYKSTRA-PARSONS COEFFICIENT                  0.83   VDP
  PRESSURE AT FORMATION TOP                  3000.0   PSIA
  PORE VOLUME COMPRESSIBILITY            0.00000300   1/PSI
  REFERENCE PRESSURE (POROSITY MEASURED)     3000.0   PSIA
  NUMBER OF LAYERS                                8
  STREAMTUBES PER LAYER                          12
  NUMBER OF GRID CELLS PER STREAMTUBE            15
  INFILL PATTERN (0=5-SPOT, 1=9-SPOT)             1

             PROPERTIES BY LAYER

    POROSITY       X-DIR PERM        NET PAY
    --------       ----------       --------
     0.0630           3.81            31.25
     0.0630           0.68            31.25
     0.0630           0.33            31.25
     0.0630           0.18            31.25
     0.0630           0.10            31.25
     0.0630           0.06            31.25
```

0.0630	0.03	31.25
0.0630	0.01	31.25

WATER DENSITY AT STANDARD CONDITIONS	64.00	LB/CUFT
WATER DENSITY AT RESERVOIR CONDITIONS.	63.99	LB/CUFT
WATER FORMATION VOLUME FACTOR	1.00	VOL/VOL
WATER COMPRESSIBILITY AT RES. COND	0.00000300	1/PSI
WATER VISCOSITY AT RES. COND	0.60	CP
OIL DENSITY AT STANDARD CONDITIONS	54.00	LB/CUFT
OIL GRAVITY	32.0	DEG API
OIL DENSITY AT RESERVOIR CONDITIONS...	43.20	LB/CUFT
OIL FORMATION VOLUME FACTOR	1.25	VOL/VOL
OIL COMPRESSIBILITY AT RES. COND	0.00000735	1/PSI
OIL VISCOSITY AT RES. COND	1.20	CP
SOLUTION GAS-OIL-RATIO	300.0	SCF/STB
GAS GRAVITY (AIR=1.0)	0.800	
INJECTION RATE (NON-INFILL)	200.0	STBW/D
INJECTION RATE (INFILL, MAY BE 0.0)	450.0	STBW/D
WATER CUT AT INFILL (VCUT)	0.600	FRAC.
WATER CUT AT END (CUTMAX)	0.900	FRAC.
PLUG BACK AT INFILL (1=NO)	2	
(2=YES, IF LAYER W-CUT GT. VCUT)		

RELATIVE PERMEABILITY DATA

IRREDUCIBLE WATER SATURATION	0.300	SWC
RESIDUAL OIL SATN -- INPUT	0.240	SORW
OIL RELATIVE PERM END-POINT	0.800	XKROE
WATER RELATIVE PERM END-POINT	0.200	XKRWE
OIL RELATIVE PERM CURVATURE	2.00	XNO
WATER RELATIVE PERM CURVATURE	2.00	XNW
(MAX) WELL DIST. FOR *CONN*.=100%	300.000	VWD100
WELL DIST. FOR CONN.=VCONEC	1320.000	VDBWLS
RESERVOIR CONNECTIVITY AT VDBWLS	0.550	VCONEC

RELATIVE PERMEABILITY TABLE FOR CONNECTIVITY = 1.00000

WATER SATURATN	OIL KRO	WATER KRW	FW (FR FLOW)	D(FW) D(SW)
0.3000	0.8000	0.0000	0.000	
0.3230	0.7220	0.0005	0.001	0.060
0.3460	0.6480	0.0020	0.006	0.207
0.3690	0.5780	0.0045	0.015	0.400
0.3920	0.5120	0.0080	0.030	0.651
0.4150	0.4500	0.0125	0.053	0.971
0.4380	0.3920	0.0180	0.084	1.369
0.4610	0.3380	0.0245	0.127	1.848
0.4840	0.2880	0.0320	0.182	2.400
0.5070	0.2420	0.0405	0.251	2.998
0.5300	0.2000	0.0500	0.333	3.590
0.5530	0.1620	0.0605	0.428	4.097
0.5760	0.1280	0.0720	0.529	4.428
0.5990	0.0980	0.0845	0.633	4.502
0.6220	0.0720	0.0980	0.731	4.278
0.6450	0.0500	0.1125	0.818	3.776
0.6680	0.0320	0.1280	0.889	3.074
0.6910	0.0180	0.1445	0.941	2.282
0.7140	0.0080	0.1620	0.976	1.502
0.7370	0.0020	0.1805	0.994	0.808
0.7600	0.0000	0.2000	1.000	0.240

FW = MOBW / (MOBW+MOBO), WHERE
MOBW = KRW/VISW, MOBO = KRO/VISO

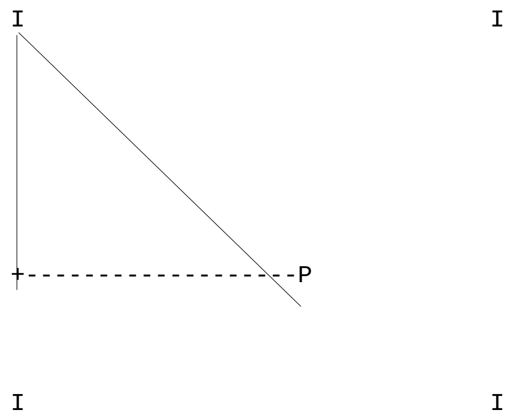
PROPERTIES BY LAYER

POROSITY	X-DIR PERM	NET PAY	S0	SW
0.0630	3.81	31.25	0.7000	0.3000
0.0630	0.68	31.25	0.7000	0.3000
0.0630	0.33	31.25	0.7000	0.3000
0.0630	0.18	31.25	0.7000	0.3000
0.0630	0.10	31.25	0.7000	0.3000
0.0630	0.06	31.25	0.7000	0.3000
0.0630	0.03	31.25	0.7000	0.3000
0.0630	0.01	31.25	0.7000	0.3000

N 0 N - I N F I L L S I M U L A T I 0 N

SYMMETRY ELEMENT WITHIN 5-SPOT, BEFORE IN-FILL

ISOTROPIC PERMEABILITY CASE 1/8



FRACTIONAL WELL RATES FOR TUBE CALCULATIONS
PRODUCER = 0.10000E+Ol
INJECTOR = -0.10000E+Ol

```
**************************************************
INJECTOR AT COORD  (  1, 65 )
PRODUCER AT COORD  ( 65,  1 )
**************************************************
```

* STREAM TUBES *

```
1
119\
135C\
1168C\
1149AC\
11378BC\
12457ABC\
113679ABC\
1124689BCC\
1124578ABCC\
11245689ABCC\
112356789ABCC\
112346789ABBCC\
1123456789ABCCC\
11234567899ABCCC\
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111111111111111111111222222222222222223333333333333444445556788BB\
11111111111111111111111111122222222222222222222233333333344456779C\
1111111111111111111111111111111111111111111112222222222234343568\
11111111111111111111111111111111111111111112211111111112121212\
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RELATIVE PERMEABILITY TABLE FOR CONNECTIVITY = 0.55000

WATER SATURATN	OIL KRO	WATER KRW	FW (FR FLOW)	D(FW) / D(SW)
0.3000	0.8000	0.0000	0.000	
0.3230	0.6612	0.0017	0.005	0.216
0.3460	0.5355	0.0066	0.024	0.831
0.3690	0.4231	0.0149	0.066	1.809
0.3920	0.3240	0.0264	0.140	3.246
0.4150	0.2380	0.0413	0.258	5.104
0.4380	0.1653	0.0595	0.419	6.994
0.4610	0.1058	0.0810	0.605	8.101
0.4840	0.0595	0.1058	0.780	7.633
0.5070	0.0264	0.1339	0.910	5.636
0.5300	0.0066	0.1653	0.980	3.056
0.5530	0.0000	0.2000	1.000	0.853
0.5760	0.0000	0.2380	1.000	0.000
0.5990	0.0000	0.2793	1.000	0.000
0.6220	0.0000	0.3240	1.000	0.000
0.6450	0.0000	0.3719	1.000	0.000
0.6680	0.0000	0.4231	1.000	0.000
0.6910	0.0000	0.4777	1.000	0.000
0.7140	0.0000	0.5355	1.000	0.000

0.7370	0.0000	0.5967	1.000	0.000
0.7600	0.0000	0.6612	1.000	0.000

FW = MOBW / (MOBW+MOBO), WHERE
MOBW = KRW/VISW, MOBO = KRO/VISO

SIMULATED FLOODING OF SYMMETRY ELEMENT STREAM TUBES

(ALL VOLUMES/RATES GIVEN BELOW ARE FOR THE SYMMETRY ELEMENT WHICH HAS 1.0/8.0 OF THE AREA OF THE PRE-INFILL 5-SPOT.)

		----IN - PLACE - VOLUMES----		
LAYER	TUBE	OIL (SCF)	WATER (SCF)	PORE VOL. (RCF)
1	1	0.66835E+05	0.35800E+05	0.11934E+06
2	1	0.66841E+05	0.35802E+05	0.11935E+06
3	1	0.66848E+05	0.35804E+05	0.11935E+06
4	1	0.66854E+05	0.35806E+05	0.11935E+06
5	1	0.66861E+05	0.35808E+05	0.11936E+06
6	1	0.66867E+05	0.35810E+05	0.11936E+06
7	1	0.66874E+05	0.35812E+05	0.11936E+06
8	1	0.66880E+05	0.35814E+05	0.11937E+06
1	2	0.50947E+05	0.27290E+05	0.90973E+05
2	2	0.50952E+05	0.27291E+05	0.90976E+05
3	2	0.50957E+05	0.27293E+05	0.90979E+05
4	2	0.50962E+05	0.27294E+05	0.90981E+05
5	2	0.50967E+05	0.27296E+05	0.90984E+05
6	2	0.50972E+05	0.27297E+05	0.90986E+05
7	2	0.50977E+05	0.27299E+05	0.90989E+05
8	2	0.50981E+05	0.27300E+05	0.90991E+05
1	3	0.53351E+05	0.28577E+05	0.95266E+05
2	3	0.53356E+05	0.28579E+05	0.95268E+05
3	3	0.53361E+05	0.28580E+05	0.95271E+05
4	3	0.53366E+05	0.28582E+05	0.95274E+05
5	3	0.53371E+05	0.28584E+05	0.95276E+05
6	3	0.53376E+05	0.28585E+05	0.95279E+05
7	3	0.53382E+05	0.28587E+05	0.95282E+05
8	3	0.53387E+05	0.28588E+05	0.95284E+05
1	4	0.43853E+05	0.23490E+05	0.78306E+05
2	4	0.43857E+05	0.23491E+05	0.78308E+05
3	4	0.43861E+05	0.23492E+05	0.78311E+05
4	4	0.43866E+05	0.23494E+05	0.78313E+05
5	4	0.43870E+05	0.23495E+05	0.78315E+05
6	4	0.43874E+05	0.23496E+05	0.78317E+05
7	4	0.43879E+05	0.23498E+05	0.78319E+05
8	4	0.43883E+05	0.23499E+05	0.78322E+05
1	5	0.37052E+05	0.19847E+05	0.66162E+05
2	5	0.37056E+05	0.19848E+05	0.66164E+05
3	5	0.37059E+05	0.19849E+05	0.66166E+05
4	5	0.37063E+05	0.19850E+05	0.66168E+05
5	5	0.37067E+05	0.19852E+05	0.66170E+05
6	5	0.37070E+05	0.19853E+05	0.66172E+05
7	5	0.37074E+05	0.19854E+05	0.66174E+05
8	5	0.37077E+05	0.19855E+05	0.66176E+05
1	6	0.35645E+05	0.19093E+05	0.66150E+05
2	6	0.35649E+05	0.19094E+05	0.63652E+05
3	6	0.35652E+05	0.19096E+05	0.63654E+05
4	6	0.35656E+05	0.19097E+05	0.63655E+05
5	6	0.35659E+05	0.19098E+05	0.63657E+05
6	6	0.35663E+05	0.19099E+05	0.63659E+05
7	6	0.35666E+05	0.19100E+05	0.63661E+05
8	6	0.35669E+05	0.19101E+05	0.63663E+05
1	7	0.34707E+05	0.18591E+05	0.61975E+05
2	7	0.34711E+05	0.18592E+05	0.61977E+05
3	7	0.34714E+05	0.18593E+05	0.61978E+05

4	7	0.34717E+05	0.18594E+05	0.61980E+05
5	7	0.34721E+05	0.18595E+05	0.61982E+05
6	7	0.34724E+05	0.18596E+05	0.61984E+05
7	7	0.34727E+05	0.18597E+05	0.61985E+05
8	7	0.34731E+05	0.18598E+05	0.61987E+05
1	8	0.32714E+05	0.17523E+05	0.58416E+05
2	8	0.32717E+05	0.17524E+05	0.58417E+05
3	8	0.32720E+05	0.17525E+05	0.58419E+05
4	8	0.32723E+05	0.17526E+05	0.58421E+05
5	8	0.32727E+05	0.17527E+05	0.58422E+05
6	8	0.32730E+05	0.17528E+05	0.58424E+05
7	8	0.32733E+05	0.17529E+05	0.58425E+05
8	8	0.32736E+05	0.17530E+05	0.58427E+05
1	9	0.29665E+05	0.15890E+05	0.52972E+05
2	9	0.29668E+05	0.15891E+05	0.52973E+05
3	9	0.29671E+05	0.15892E+05	0.52975E+05
9	9	0.29674E+05	0.15893E+05	0.52976E+05
5	9	0.29677E+05	0.15894E+05	0.52978E+05
6	9	0.29680E+05	0.15895E+05	0.52979E+05
7	9	0.29683E+05	0.15896E+05	0.52981E+05
8	9	0.29685E+05	0.15896E+05	0.52982E+05
1	10	0.28844E+05	0.15451E+05	0.51506E+05
2	10	0.28847E+05	0.15451E+05	0.51508E+05
3	10	0.28850E+05	0.15452E+05	0.51509E+05
4	10	0.28853E+05	0.15453E+05	0.51511E+05
5	10	0.28856E+05	0.15454E+05	0.51512E+05
6	10	0.28858E+05	0.15455E+05	0.51513E+05
7	10	0.28861E+05	0.15456E+05	0.51515E+05
8	10	0.28864E+05	0.15467E+05	0.51516E+05
1	11	0.30369E+05	0.16267E+05	0.54228E+05
2	11	0.30372E+05	0.16268E+05	0.54230E+05
3	11	0.30375E+05	0.16269E+05	0.54231E+05
4	11	0.30378E+05	0.16270E+05	0.54233E+05
5	11	0.30381E+05	0.16271E+05	0.54234E+05
6	11	0.30384E+05	0.16272E+05	0.54236E+05
7	11	0.30386E+05	0.16273E+05	0.54237E+05
8	11	0.30389E+05	0.16273E+05	0.54239E+05
1	12	0.36349E+05	0.19470E+05	0.64906E+05
2	12	0.36352E+05	0.19471E+05	0.64908E+05
3	12	0.36356E+05	0.19472E+05	0.64910E+05
4	12	0.36359E+05	0.19473E+05	0.64912E+05
5	12	0.36363E+05	0.19475E+05	0.64914E+05
6	12	0.36366E+05	0.19476E+05	0.64915E+05
7	12	0.36370E+05	0.19477E+05	0.64917E+05
8	12	0.36373E+05	0.19478E+05	0.64919E+05
TOTALS		0.38439E+07	0.20587E+07	0.68623E+07
(M-STB)		684.59	366.65	

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
0.2	81.5	81.466	1	1

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
14.63	0.9142E-11	25.00	1192.	0.7447E-09	2037.

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
683.39	368.68	3444.4

MATERIAL BALANCE ERROR

OIL WATER

1.0000	1.0000

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
0.4	162.9	81.466	2	2

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
17.27	0.6948E-11	25.00	2599.	0.5660E-03	4074.

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
681.99	370.72	3789.8

MATERIAL BALANCE ERROR	
OIL	WATER
1.0000	1.0000

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
6.9	2525.4	81.466	31	31

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
8.108	14.60	25.00	0.43978E+05	0.1104E+05	0.6315E+05

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
644.78	418.71	4114.0

MATERIAL BALANCE ERROR	
OIL	WATER
0.99995	0.99990

CONTINUATION OF WATERFLOOD AFTER WATER CUT FOR INFILL

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
7.1	2606.9	81.466	1	32

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
7.360	15.47	25.00	0.4038E+05	0.1230E+05	0.6518E+05

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
644.18	419.48	4200.8

MATERIAL BALANCE ERROR	
OIL	WATER
0.99995	0.99991

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
13.4	4887.9	81.466	29	60

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
5.452	18.13	25.00	0.5339E+05	0.5295E+05	0.1222E+06

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
631.11	435.96	4242.2

MATERIAL BALANCE ERROR	
OIL	WATER
0.99986	1.0001

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                    PERIODIC REPORT ON STATUS OF SIMULATION

          YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
          26.8       9774.9    81.466         89                 120

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL        WATER       INJECTION         OIL         WATER        INJECTION
    3.992    20.00            25.00       0.7795E+05   0.1442E+06   0.2444E+06

     CURRENT IN-PLACE-VOLUMES                              MAXIMUM
OIL (MSTB)        WATER (MSTB)                            PRESSURE
606.43              467.15                                  4189.3

     MATERIAL BALANCE ERROR
OIL               WATER
0.99967           1.0007


                    PERIODIC REPORT ON STATUS OF SIMULATION

          YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
          40.1       14663.8   81.466         149                180

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL        WATER       INJECTION         OIL         WATER        INJECTION
    3.141    21.07            25.00       0.9509E+05   0.2448E+06   0.3667E+06

     CURRENT IN-PLACE-VOLUMES                              MAXIMUM
OIL (MSTB)        WATER (MSTB)                            PRESSURE
589.21              488.92                                  4224.2

     MATERIAL BALANCE ERROR
OIL               WATER
0.99956           1.0012


*****************


TIME STEPS EXECUTED       229
GRID-CELL-TIME-STEPS 2638080
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I N F I L L   S I M U L A T I O N

SYMMETRY ELEMENT AFTER 9-SPOT IN-FILL

ISOTROPIC PERMEABILITY CASE - 1/8

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I              P              I




P              P              P




I              P              I
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FRACTIONAL WELL RATES FOR TUBE CALCULATIONS
         NEW PRODUCER  =    0.6600E+00
         OLD PRODUCER  =   0.33400E+00
             INJECTOR  =  -0.10000E+01
*************************************************
    INJECTOR AT COORD (  1, 65 )
    PRODUCER AT COORD ( 65,  1 )
    PRODUCER AT COORD (  1,  1 )
```

STREAM TUBES

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1
1B
27C
158C
139AC
1468BC
23679BC
13479BBC
135789ACC
124578ABCC
1345689ABCC
12356789ABCC
12346789ABBCC
123456789ABCCC
1234567899ABCCC
1234567789ABBCCC
12345567899ABBCCC
12344567889AABBCCC
113345677899AABCCCC
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1123445556666777778888888999999999AAAAAAAAAAABBBBBBCCCCCC
113344556666777778888888899999999AAAAAAAAAAABBBBBBBCCCCC
22244556667777788888888899999999999AAAAAAAAAAAABBBBBBCCCCC
12344566667777788888888888999999999999AAAAAAAAAAAABBBBBCCCC
123456667777788888888888899999999999999999AAAAAAAAAAABBBBCCCC
1345667777788888888888888999999999999999999AAAAAAAAAAAABBBCCC
245677777888888888888888889999999999999999999999999AAAAAAABBBCC
14677888888888888888888888899999999999999999999999999999999AAAAAABC
188888888888888888888888889999999999999999999999999999999999999999A9
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RELATIVE PERMEABILITY TABLE FOR CONNECTIVITY = 0.68988

WATER SATURATN	OIL KRO	WATER KRW	FW (FR FLOW)	D(FW) / D(SW)
0.3000	0.8000	0.0000	0.000	
0.3230	0.6882	0.0011	0.003	0.132
0.3460	0.5849	0.0042	0.014	0.484
0.3690	0.4899	0.0095	0.037	0.000
0.3920	0.4034	0.0168	0.077	1.729
0.4150	0.3252	0.0263	0.139	2.701
0.4380	0.2555	0.0378	0.228	3.886
0.4610	0.1942	0.0515	0.346	5.134
0.4840	0.1412	0.0672	0.488	6.140
0.5070	0.0967	0.0851	0.638	6.518
0.5300	0.0606	0.1051	0.776	6.022
0.5530	0.0329	0.1271	0.885	4.753
0.5760	0.0136	0.1513	0.957	3.113
0.5990	0.0027	0.1775	0.993	1.543
0.6220	0.0000	0.2059	1.000	0.325
0.6450	0.0000	0.2364	1.000	0.000
0.6680	0.0000	0.2689	1.000	0.000
0.6910	0.0000	0.3036	1.000	0.000
0.7140	0.0000	0.3404	1.000	0.000
0.7370	0.0000	0.3793	1.000	0.000
0.7600	0.0000	0.4202	1.000	0.000

FW = MOBW / (MOBW+MOBO), WHERE
MOBW = KRW/VISW, MOBO = KRO/VISO

SIMULATED FLOODING OF SYMMETRY ELEMENT STREAM TUBES

(ALL VOLUMES/RATES GIVEN BELOW ARE FOR THE SYMMETRY ELEMENT WHICH HAS 1.0/8.0 OF THE AREA OF THE PRE-INFILL 5-SPOT.)

		----IN - PLACE - VOLUMES----		
LAYER	TUBE	OIL (SCF)	WATER (SCF)	PORE VOL. (RCF)
1	1	0.10872E+05	0.15889E+05	0.29375E+05
2	1	0.13320E+05	0.12787E+05	0.29357E+05
3	1	0.14794E+05	0.10938E+05	0.29354E+05
4	1	0.15546E+05	0.99921E+04	0.29351E+05
5	1	0.15948E+05	0.94801E+04	0.29347E+05
6	1	0.16180E+05	0.91762E+04	0.29342E+05
7	1	0.16318E+05	0.89843E+04	0.29336E+05
8	1	0.16403E+05	0.88563E+04	0.29328E+05
1	2	0.10908E+05	0.15847E+05	0.29376E+05
2	2	0.13800E+05	0.12161E+05	0.29348E+05
3	2	0.15238E+05	0.10363E+05	0.29346E+05
4	2	0.15784E+05	0.96777E+04	0.29345E+05
5	2	0.16077E+05	0.93060E+04	0.29343E+05
6	2	0.16249E+05	0.90803E+04	0.29339E+05
7	2	0.16351E+05	0.89368E+04	0.29334E+05
8	2	0.16410E+05	0.88413E+04	0.29326E+05
1	3	0.15764E+05	0.22815E+05	0.42379E+05
2	3	0.20470E+05	0.16828E+05	0.42337E+05
3	3	0.22065E+05	0.14833E+05	0.42336E+05
4	3	0.22811E+05	0.13898E+05	0.42334E+05
5	3	0.23215E+05	0.13389E+05	0.42332E+05
6	3	0.23453E+05	0.13081E+05	0.42328E+05
7	3	0.23596E+05	0.12884E+05	0.42322E+05
8	3	0.23678E+05	0.12753E+05	0.42313E+05
1	4	0.15978E+05	0.22954E+05	0.42793E+05
2	4	0.21113E+05	0.16435E+05	0.42752E+05
3	4	0.22625E+05	0.14543E+05	0.42751E+05
4	4	0.23256E+05	0.13752E+05	0.42750E+05
5	4	0.23578E+05	0.13348E+05	0.42749E+05
6	4	0.23761E+05	0.13112E+05	0.42746E+05
7	4	0.23866E+05	0.12964E+05	0.42740E+05
8	4	0.23923E+05	0.12864E+05	0.42731E+05
1	5	0.17253E+05	0.24730E+05	0.46150E+05
2	5	0.23036E+05	0.17388E+05	0.46105E+05
3	5	0.24439E+05	0.15633E+05	0.46103E+05
4	5	0.25090E+05	0.14818E+05	0.46103E+05
5	5	0.25431E+05	0.14391E+05	0.46102E+05
6	5	0.25628E+05	0.14138E+05	0.46099E+05
7	5	0.25741E+05	0.13979E+05	0.46094E+05
8	5	0.25801E+05	0.13872E+05	0.46083E+05
1	6	0.20293E+05	0.28915E+05	0.54118E+05
2	6	0.27397E+05	0.19906E+05	0.54065E+05
3	6	0.29000E+05	0.17902E+05	0.54064E+05
4	6	0.29607E+05	0.17144E+05	0.54064E+05
5	6	0.29932E+05	0.16736E+05	0.54063E+05
6	6	0.30115E+05	0.16501E+05	0.54061E+05
7	6	0.30217E+05	0.16354E+05	0.54054E+05
8	6	0.30265E+05	0.16256E+05	0.54041E+05
1	7	0.25743E+05	0.36398E+05	0.68377E+05
2	7	0.35090E+05	0.24556E+05	0.68313E+05
3	7	0.36756E+05	0.22472E+05	0.68311E+05
4	7	0.37472E+05	0.21578E+05	0.68311E+05
5	7	0.37850E+05	0.21106E+05	0.68311E+05
6	7	0.38066E+05	0.20828E+05	0.68308E+05
7	7	0.38187E+05	0.20654E+05	0.68300E+05
8	7	0.38242E+05	0.20538E+05	0.68284E+05
1	8	0.37077E+05	0.51012E+05	0.97097E+05
2	8	0.51446E+05	0.32847E+05	0.97014E+05

3	8	0.53065E+05	0.30824E+05	0.97013E+05
4	8	0.53680E+05	0.30058E+05	0.97013E+05
5	8	0.54001E+05	0.29655E+05	0.97013E+05
6	8	0.54190E+05	0.29407E+05	0.97009E+05
7	8	0.54290E+05	0.29248E+05	0.96997E+05
8	8	0.54324E+05	0.29141E+05	0.96976E+05
1	9	0.51886E+05	0.65706E+05	0.13029E+05
2	9	0.69859E+05	0.43017E+05	0.13020E+05
3	9	0.71503E+05	0.40966E+05	0.13020E+05
4	9	0.72184E+05	0.40120E+05	0.13020E+05
5	9	0.72555E+05	0.39660E+05	0.13020E+05
6	9	0.72765E+05	0.39391E+05	0.13020E+05
7	9	0.72892E+05	0.39202E+05	0.13019E+05
8	9	0.72912E+05	0.39110E+05	0.13017E+05
1	10	0.41614E+05	0.57840E+05	0.10964E+05
2	10	0.58273E+05	0.36835E+05	0.10956E+05
3	10	0.60061E+05	0.34604E+05	0.10956E+05
4	10	0.60751E+05	0.33749E+05	0.10957E+05
5	10	0.61057E+05	0.33373E+05	0.10957E+05
6	10	0.61238E+05	0.33146E+05	0.10957E+05
7	10	0.61339E+05	0.32999E+05	0.10956E+05
8	10	0.61350E+05	0.32926E+05	0.10954E+05
1	11	0.35841E+05	0.51628E+05	0.96226E+05
2	11	0.50612E+05	0.33006E+05	0.96162E+05
3	11	0.52338E+05	0.30853E+05	0.96162E+05
4	11	0.53078E+05	0.29933E+05	0.96163E+05
5	11	0.53453E+05	0.29469E+05	0.96164E+05
6	11	0.53687E+05	0.29176E+05	0.96164E+05
7	11	0.53807E+05	0.29006E+05	0.96157E+05
8	11	0.53854E+05	0.28890E+05	0.96138E+05
1	12	0.42243E+05	0.60605E+05	0.11319E+06
2	12	0.60114E+05	0.38084E+05	0.11312E+06
3	12	0.61923E+05	0.35829E+05	0.11312E+06
4	12	0.62588E+05	0.35007E+05	0.11312E+06
5	12	0.62949E+05	0.34563E+05	0.11312E+06
6	12	0.63178E+05	0.34278E+05	0.11313E+06
7	12	0.63306E+05	0.34102E+05	0.11312E+06
8	12	0.63372E+05	0.33964E+05	0.11310E+06
TOTALS		0.36207E+07	0.23508E+07	0.68668E+07
(M-STB)		644.82	418.66	

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
7.0	2566.2	40.733	1	32

PRODUCTION/INJECTION RATE (STB/D) CUMULATIVE PRODUCTION/INJECTION (STB)

	OIL	WATER	INJECTION	OIL	WATER	INJECTION
	23.80	26.36	56.26	969.5	1074	2292
(	15.76	19.65	- FROM WELL AT (1, 1))			
(	8.046	6.707	- FROM WELL AT (65, 1))			

CURRENT IN-PLACE-VOLUMES

OIL (MSTB)	WATER (MSTB)	MAXIMUM PRESSURE
643.79	419.97	6478.3

MATERIAL BALANCE ERROR

OIL	WATER
0.99990	1.0002

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS DAYS DELTA-T CASE STEPS TOTAL STEPS

7.1	2606.9	40.733	2	33

PRODUCTION/INJECTION RATE (STB/D) CUMULATIVE PRODUCTION/INJECTION (STB)

	OIL	WATER	INJECTION	OIL	WATER	INJECTION
	21.29	27.93	56.26	1837.	2211.	4583.
(	13.31	20.31	- FROM WELL AT (1, 1))			
(	7.976	7.618	- FROM WELL AT (65, 1))			

CURRENT IN-PLACE- VOLUMES MAXIMUM

OIL (MSTB)	WATER (MSTB)	PRESSURE
642.92	421.13	6234.2

MATERIAL BALANCE ERROR

OIL	WATER
0.9990	1.0002

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
12.9	4725.0	40.733	54	85

PRODUCTION/INJECTION RATE (STB/D) CUMULATIVE PRODUCTION/INJECTION (STB)

	OIL	WATER	INJECTION	OIL	WATER	INJECTION
	11.50	41.83	56.26	0.3323E+05	0.8190E+05	0.1237E+06
(	7.019	28.81	- FROM WELL AT (1, 1))			
(	4.484	13.02	- FROM WELL AT (65, 1))			

CURRENT IN-PLACE-VOLUMES MAXIMUM

OIL (MSTB)	WATER (MSTB)	PRESSURE
611.48	460.80	6035.7

MATERIAL BALANCE ERROR

OIL	WATER
0.99981	1.0007

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
18.8	6883.9	40.733	107	138

PRODUCTION/INJECTION RATE (STB/D) CUMULATIVE PRODUCTION/INJECTION (STB)

	OIL	WATER	INJECTION	OIL	WATER	INJECTION
	8.724	45.35	56.26	0.5438E+05	0.1769E+06	0.2452E+06
(	4.614	31.86	- FROM WELL AT (1, 1))			
(	4.110	13.49	- FROM WELL AT (65, 1))			

CURRENT IN-PLACE-VOLUMES MAXIMUM

OIL (MSTB)	WATER (MSTB)	PRESSURE
590.24	487.53	6063.8

MATERIAL BALANCE ERROR

OIL	WATER
0.99967	1.0013

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
24.9	9083.4	40.733	161	192

PRODUCTION/INJECTION RATE (STB/D) CUMULATIVE PRODUCTION/INJECTION (STB)

	OIL	WATER	INJECTION	OIL	WATER	INJECTION
	7.425	46.96	56.26	0.7238E+05	0.2781E+06	0.3689E+06
(	3.654	33.08	- FROM WELL AT (1, 1))			
(	3.772	13.88	- FROM WELL AT (65, 1))			

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
572.16	510.31	6134.7

MATERIAL BALANCE ERROR	
OIL	WATER
0.99955	1.0019

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TIME STEPS EXECUTED	208
GRID-CELL-TIME-STEPS	2396160

PERFORMANCE VERSUS TIME FOR NON-INFILL

TIME DAYS	OIL RATE STB/D	WATER RATE STB/D	CUMOIL MSTB	WCUT FRAC.	PV INJ FRAC.	OIL REC %OOIP
81.47	14.63	0.9142E-11	1.192	0.000	0.00	0.2
162.93	17.27	0.6948E-05	2.599	0.000	0.00	0.4
244.40	18.24	0.7490E-04	4.085	0.000	0.01	0.6
325.86	18.69	0.7655E-04	5.607	0.000	0.01	0.8
407.33	18.99	0.7776E-04	7.154	0.000	0.01	1.0
488.79	19.14	0.4390E-04	8.713	0.000	0.01	1.3
570.26	19.27	0.4339E-04	10.28	0.000	0.01	1.5
651.73	19.35	0.4349E-04	11.86	0.000	0.01	1.7
733.19	19.43	0.1010E-03	13.44	0.000	0.02	2.0
814.66	19.51	0.1380E-03	15.03	0.000	0.02	2.2
896.12	19.58	0.1791E-03	16.63	0.000	0.02	2.4
977.59	19.56	0.1483E-03	18.22	0.000	0.02	2.7
1059.05	19.58	0.1197E-03	19.82	0.000	0.02	2:9
1140.52	19.58	0.1389E-03	21.41	0.000	0.02	3.1
1221.99	19.62	0.1307E-03	23.01	0.000	0.03	3.4
1303.45	19.62	0.1910E-03	24.61	0.000	0.03	3.6
1384.92	19.52	0.2115E-03	26.20	0.000	0.03	3.8
1466.38	19.43	0.4265E-03	27.78	0.000	0.03	4.1
1547.85	17.99	1.957	29.25	0.098	0.03	4.3
1629.31	15.93	4.448	30.54	0.218	0.03	4.5
1710.78	14.80	5.803	31.75	0.282	0.04	4.6
1792.25	12.27	9.270	32.75	0.430	0.04	4.8
1873.71	10.57	11.45	33.61	0.520	0.04	4.9
1955.18	10.40	11.64	34.46	0.528	0.04	5.0
2036.64	10.40	11.67	35.31	0.529	0.04	5.2
2118.11	10.14	12.02	36.13	0.542	0.04	5.3
2199.57	9.318	13.04	36.89	0.583	0.05	5.4
2281.04	9.202	13.10	37.64	0.587	0.05	5.5
2362.50	9.113	13.16	38.38	0.591	0.05	5.6
2443.97	9.018	13.38	39.12	0.597	0.05	5.7
2525.44	8.108	14.60	39.78	0.643	0.05	5.8
2606.90	7.360	15.47	40.38	0.678	0.05	5.9
2688.37	7.127	15.89	40.96	0.690	0.06	6.0
2769.83	6.614	16.62	41.50	0.715	0.06	6.1
2851.30	6.003	17.44	41.99	0.744	0.06	6.1
2932.76	5.920	17.58	42.47	0.748	0.06	6.2
3014.23	5.837	17.67	42.94	0.752	0.06	6.3
3095.69	5.814	17.72	43.42	0.753	0.06	6.3
3177.16	5.757	17.79	43.89	0.755	0.07	6.4
3258.63	5.713	17.84	44.35	0.757	0.07	6.5
3340.09	5.693	17.87	44.82	0.758	0.07	6.5
3421.56	5.662	17.90	45.28	0.760	0.07	6.6
3503.02	5.609	17.93	45.73	0.762	0.07	6.7
3584.49	5.607	17.96	46.19	0.762	0.07	6.8
3665.95	5.627	17.96	46.65	0.761	0.08	6.8
3747.42	5.589	17.98	47.10	0.763	0.08	6.9
3828.89	5.587	17.98	47.56	0.763	0.08	7.0

3910.35	5.569	18.00	48.01	0.764	0.08	7.0
3991.82	5.536	18.01	48.46	0.765	0.08	7.1
4073.28	5.543	18.01	48.92	0.765	0.08	7.1
4154.75	5.531	18.05	49.37	0.765	0.09	7.2
4236.21	5.532	18.04	49.82	0.765	0.09	7.3
4317.68	5.509	18.06	50.27	0.766	0.09	7.3
4399.15	5.512	18.07	50.72	0.766	0.09	7.4
4480.61	5.507	18.07	51.16	0.766	0.09	7.5
4562.08	5.488	18.08	51.61	0.767	0.09	7.5
4643.54	5.498	18.10	52.06	0.767	0.10	7.6
4725.01	5.470	18.09	52.50	0.768	0.10	7.7
4806.47	5.461	18.11	52.95	0.768	0.10	7.7
4887.94	5.452	18.13	53.39	0.769	0.10	7.8
4969.41	5.486	18.09	53.84	0.767	0.10	7.9
5050.87	5.434	18.14	54.28	0.769	0.10	7.9
5132.34	5.470	18.13	54.73	0.768	0.11	8.0
5213.80	5.467	18.13	55.17	0.768	0.11	8.1
5295.27	5.462	18.16	55.62	0.769	0.11	8.1
5376.73	5.448	18.16	56.06	0.769	0.11	8.2
5458.20	5.441	18.16	56.51	0.769	0.11	8.3
5539.67	5.442	18.17	56.95	0.769	0.11	8.3
5621.13	5.406	18.19	57.39	0.771	0.12	8.4
5702.60	5.397	18.20	57.83	0.771	0.12	8.5
5784.06	5.418	18.20	58.27	0.771	0.12	8.5
5865.53	5.415	18.20	58.71	0.771	0.12	8.6
5947.00	5.418	18.20	59.15	0.771	0.12	8.6
6028.46	5.411	18.19	59.59	0.771	0.12	8.7
6109.93	5.370	18.22	60.03	0.772	0.13	8.8
6191.39	5.369	18.23	60.47	0.772	0.13	8.8
6272.86	5.390	18.22	60.91	0.772	0.13	8.9
6354.32	5.347	18.24	61.34	0.713	0.13	9.0
6435.79	5.345	18.24	61.78	0.773	0.13	9.0
6517.26	5.363	18.22	62.22	0.773	0.13	9.1
6598.72	5.334	18.24	62.65	0.774	0.14	9.2
6680.19	5.357	18.23	63.09	0.773	0.14	9.2
6761.65	5.353	18.25	63.52	0.773	0.14	9.3
6843.12	5.346	18.23	63.96	0.773	0.14	9.3
6924.59	5.295	18.27	64.39	0.775	0.14	9.4
7006.05	5.309	18.27	64.82	0.775	0.14	9.5
7087.52	5.293	18.29	65.25	0.776	0.15	9.5
7168.98	5.296	18.26	65.69	0.775	0.15	9.6
7250.45	5.284	18.27	66.12	0.776	0.15	9.7
7331.91	5.272	18.31	66.54	0.776	0.15	9.7
7413.38	5.273	18.30	66.97	0.776	0.15	9.8
7494.85	5.244	18.36	67.40	0.778	0.15	9.9
7576.31	5.215	18.39	67.83	0.779	0.16	9.9
7657.78	5.167	18.45	68.25	0.781	0.~6	10.0
7739.24	5.108	18.52	68.66	0.784	0.16	10.0
7820.71	5.097	18.57	69.08	0.785	0.16	10.1
7902.18	5.031	18.65	69.49	0.788	0.16	10.2
7983.64	4.942	18.76	69.89	0.791	0.16	10.2
8065.11	4.902	18.81	70.29	0.793	0.17	10.3
8146.57	4.856	18.86	70.69	0.795	0.17	10.3
8228.04	4.832	18.89	71.08	0.796	0.17	10.4
8309.50	4.783	18.94	71.47	0.798	0.17	10.4
8390.97	4.761	18.96	71.86	0.799	0.17	10.5
8472.44	4.723	19.01	72.24	0.801	0.17	10 6
8553.90	4.695	19.06	72.62	0.802	0.18	10.6
8635.37	4.644	19.11	73.00	0.805	0.18	10.7
8716.83	4.630	19.14	73.38	0.805	0.18	10.7
8798.30	4.602	19.19	73.76	0.807	0.18	10.8
8879.76	4.590	19.22	74.13	0.807	0.18	10.8
8961.23	4.549	19.29	74.50	0.809	0.18	10.9
9042.70	4.498	19.35	74.87	0.811	0.19	10.9
9124.16	4.456	19.41	75.23	0.813	0.19	11.0
9205.63	4.386	19.51	75.59	0.816	0.19	11.0
9287.09	4.317	19.60	75.94	0.820	0.19	11.1

9368.56	4.227	19.69	76.28	0.823	0.19	11.1
9450.03	4.216	19.73	76.63	0.824	0.19	11.2
9531.49	4.115	19.82	76.96	0.828	0.20	11.2
9612.96	4.084	19.88	77.29	0.830	0.20	11.3
9694.42	4.055	19.92	77.62	0.831	0.20	11.3
9775.89	3.992	20.00	77.95	0.834	0.20	11.4
9857.35	3.948	20.05	78.27	0.835	0.20	11.4
9938.82	3.910	20.10	78.59	0.837	0.20	11.5
10020.29	3.912	20.12	78.91	0.837	0.21	11.5
10101.75	3.866	20.16	79.22	0.839	0.21	11.6
10183.22	3.864	20.17	79.54	0.839	0.21	11.6
10264.68	3.844	20.19	79.85	0.840	0.21	11.7
10346.15	3.816	20.22	80.16	0.841	0.21	11.7
10427.62	3.793	20.23	80.47	0.842	0.21	11.8
10509.08	3.780	20.26	80.78	0.843	0.22	11.8
10590.55	3.783	20.26	81.09	0.843	0.22	11.9
10672.01	3.752	20.29	81.39	0.844	0.22	11.9
10753.48	3.758	20.29	81.70	0.844	0.22	11.9
10834.94	3.726	20.33	82.00	0.845	0.22	12.0
10916.41	3.697	20.36	82.30	0.846	0.22	12.0
10997.88	3.715	20.35	82.61	0.846	0.23	12.1
11079.34	3.688	20.39	82.91	0.847	0.23	12.1
11160.81	3.705	20.37	83.21	0.846	0.23	12.2
11242.27	3.652	20.41	83.51	0.848	0.23	12.2
11323.74	3.681	20.41	83.81	0.847	0.23	12.2
11405.21	3.633	20.45	84.10	0.849	0.23	12.3
11486.67	3.629	20.45	84.40	0.849	0.24	12.3
11568.14	3.615	20.50	84.69	0.850	0.24	12.4
11649.60	3.591	20.52	84.98	0.851	0.24	12.4
11731.07	3.547	20.55	85.27	0.853	0.24	12.5
11812.53	3.543	20.55	85.56	0.853	0.24	12.5
11894.00	3.517	20.57	85.85	0.854	0.24	12.5
11975.47	3.502	20.59	86.13	0.855	0.25	12.6
12056.93	3.526	20.59	86.42	0.854	0.25	12.6
12138.40	3.500	20.61	86.71	0.855	0.25	12.7
12219.86	3.458	20.63	86.99	0.856	0.25	12.7
12301.33	3.451	20.64	87.27	0.857	0.25	12.8
12382.79	3.477	20.63	87.55	0.856	0.25	12.8
12464.26	3.423	20.66	87.83	0.858	0.26	12.8
12545.73	3.474	20.64	88.11	0.856	0.26	12.9
12627.19	3.425	20.69	88.39	0.858	0.26	12.9
12708.66	3.423	20.68	88.67	0.858	0.26	13.0
12790.12	3.403	20.70	88.95	0.859	0.26	13.0
12871.59	3.408	20.70	89.23	0.859	0.26	13.0
12953.06	3.417	20.70	89.51	0.858	0.27	13.1
13034.52	3.381	20.72	89.78	0.860	0.27	13.1
13115.99	3.392	20.72	90.06	0.859	0.27	13.2
13197.45	3.377	20.72	90.33	0.860	0.27	13.2
13278.92	3.369	20.74	90.61	0.860	0.27	13.2
13360.38	3.364	20.75	90.88	0.861	0.27	13.3
13441.85	3.343	20.78	91.15	0.861	0.28	13.3
13523.32	3.342	20.80	91.43	0.862	0.28	13.4
13604.78	3.319	20.80	91.70	0.862	0.28	13.4
13686.25	3.305	20.83	91.97	0.863	0.28	13.4
13767.71	3.296	20.86	92.23	0.864	0.28	13.5
13849.18	3.300	20.85	92.50	0.863	0.28	13 5
13930.65	3.256	20.88	92.77	0.865	0.29	13.6
14012.11	3.258	20.89	93.03	0.865	0.29	13.6
14093.58	3.216	20.93	93.30	0.867	0.29	13.6
14175.04	3.200	20.93	93.56	0.867	0.29	13.7
14256.51	3.178	20.97	93.81	0.868	0.29	13.7
14337.97	3.146	20.98	94.07	0.870	0.29	13.7
14419.44	3.166	21.01	94.33	0.869	0.30	13.8
14500.91	3.129	21.04	94.58	0.871	0.30	13.8
14582.37	3.118	21.05	94.84	0.871	0.30	13.9
14663.84	3.141	21.07	95.09	0.870	0.30	13.9
14745.30	3.127	21.07	95.35	0.871	0.30	13.9

14826.77	3.085	21.10	95.60	0.872	0.30	14.0
14908.24	3.077	21.13	95.85	0.873	0.31	14.0
14989.70	3.068	21.14	96.10	0.873	0.31	14.0
15071.17	3.053	21.16	96.35	0.874	0.31	14.1
15152.63	3.036	21.21	96.60	0.875	0.31	14.1
15234.10	3.005	21.23	96.84	0.876	0.31	14.2
15315.56	2.994	21.24	97.09	0.876	0.31	14.2
15397.03	2.987	21.27	97.33	0.877	0.32	14.2
15478.50	2.931	21.31	97.57	0.879	0.32	14.3
15559.96	2.941	21.32	97.81	0.879	0.32	14.3
15641.43	2.919	21.36	98.04	0.880	0.32	14.3
15722.89	2.906	21.38	98.28	0.880	0.32	14.4
15804.36	2.894	21.39	98.52	0.881	0.32	14.4
15885.83	2.837	21.44	98.75	0.883	0.33	14.4
15967.29	2.850	21.45	98.98	0.883	0.33	14.5
16048.76	2.824	21.47	99.21	0.884	0.33	14.5
16130.22	2.813	21.49	99.44	0.884	0.33	14.5
16211.69	2.779	21.52	99.67	0.886	0.33	14.6
16293.15	2.776	21.54	99.89	0.886	0.33	14.6
16374.62	2.737	21.58	100.1	0.887	0.34	14.6
16456.09	2.725	21.58	100.3	0.888	0.34	14.7
16537.55	2.709	21.63	100.6	0.889	0.34	14.7
16619.02	2.714	21.63	100.8	0.889	0.34	14.7
16700.48	2.662	21.65	101.0	0.891	0.34	14.8
16781.95	2.661	21.67	101.2	0.891	0.34	14.8
16863.41	2.656	21.69	101.4	0.891	0.35	14.8
16944.88	2.651	21.71	101.6	0.891	0.35	14.9
17026.34	2.617	21.72	101.9	0.892	0.35	14.9
17107.80	2.642	21.73	102.1	0.892	0.35	14.9
17189.27	2.611	21.75	102.3	0.893	0.35	14.9
17270.73	2.605	21.76	102.5	0.893	0.35	15.0
17352.20	2.582	21.78	102.7	0.894	0.36	15.0
17433.66	2.564	21.79	102.9	0.895	0.36	15.0
17515.13	2.571	21.78	103.1	0.894	0.36	15.1
17596.59	2.561	21.79	103.3	0.895	0.36	15.1
17678.06	2.559	21.81	103.5	0.895	0.36	15.1
17759.52	2.530	21.85	103.7	0.896	0.36	15.2
17840.99	2.529	21.85	104.0	0.896	0.37	15.2
17922.45	2.507	21.87	104.2	0.897	0.37	15.2
18003.92	2.505	21.88	104.4	0.897	0.37	15.3
18085.38	2.500	21.89	104.6	0.898	0.37	15.3
18166.85	2.491	21.90	104.8	0.898	0.37	15.3
18248.31	2.469	21.91	105.0	0.899	0.37	15.3
18329.78	2.464	21.93	105.2	0.899	0.38	15.4
18411.24	2.467	21.93	105.4	0.899	0.38	15.4
18492.71	2.468	21.96	105.6	0.899	0.38	15.4
18574.17	2.448	21.95	105.8	0.900	0.38	15.5
18655.64	2.428	21.98	106.0	0.901	0.38	15.5

PERFORMANCE VERSUS TIME FOR INFILL

TIME DAYS	OIL RATE STB/D	WATER RATE STB/D	CUMOIL MSTB	WCUT FRAC.	PV INJ FRAC.	OIL REC %OOIP
2525.44	3.951	24.47	39.78	0.861	0.05	
2566.17	23.80	26.36	40.75	0.526	0.05	6.0
2606.90	21.29	27.93	41.61	0.567	0.06	6.1
2647.63	21.15	28.72	42.48	0.576	0.06	6.2
2688.37	20.95	29.32	43.33	0.583	0.06	6.3
2729.10	20.45	30.19	44.16	0.596	0.06	6.5
2769.83	21.64	28.89	45.04	0.572	0.06	6.6
2810.57	21.67	29.02	45.93	0.573	0.06	6.7
2851.30	18 22	33.51	46.67	0.648	0.07	6.8
2892.03	18.23	33.39	47.41	0.647	0.07	6.9
2932.76	22.12	28.29	48.31	0.561	0.07	7.1
2973.50	17.28	34.62	49.02	0.667	0.07	7.2
3014.23	19.99	31.25	49.83	0.610	0.07	7.3
3054.96	19.97	31.05	50.64	0.609	0.08	7.4
3095.70	16.75	35.19	51.33	0.678	0.08	7.5
3136.43	16.62	35.45	52.00	0.681	0.08	7.6
3177.16	16.05	36.12	52.66	0.692	0.08	7.7
3217.90	15.90	36.32	53.30	0.696	0.08	7.8
3258.63	15.70	36.53	53.94	0.699	0.09	7.9
3299.36	15.45	36.83	54.57	0.704	0.09	8.0
3340.09	15.24	37.12	55.19	0.709	0.09	8.1
3380.83	15.08	37.34	55.81	0.712	0.09	8.2
3421.56	14.91	37.59	56.42	0.716	0.09	8.2
3462.29	14.56	38.03	57.01	0.723	0.09	8.3
3503.03	14.38	38.27	57.60	0.727	0.10	8.4
3543.76	14.16	38.50	58.17	0.731	0.10	8.5
3584.49	14.03	38.71	58.74	0.734	0.10	8.6
3625.22	13.84	38.90	59.31	0.738	0.10	8.7
3665.96	13.77	39.01	59.87	0.739	0.10	8.7
3706.69	13.62	39.21	60.42	0.742	0.11	8.8
3747.42	13.51	39.34	60.97	0.744	0.11	8.9
3788.16	13.36	39.53	61.52	0.747	0.11	9.0
3828.89	13.18	39.75	62.05	0.751	0.11	9.1
3869.62	12.98	39.97	62.58	0.755	0.11	9.1
3910.35	12.86	40.17	63.11	0.758	0.12	9.2
3951.09	12.79	40.25	63.63	0.759	0.12	9.3
3991.82	12.72	40.31	64.15	0.760	0.12	9.4
4032.55	12.58	40.45	64.66	0.763	0.12	9.4
4073.29	12.48	40.62	65.17	0.765	0.12	9.5
4114.02	12.48	40.62	65.67	0.765	0.12	9.6
4154.75	12.39	40.75	66.18	0.767	0.13	9.7
4195.48	12.29	40.82	66.68	0.769	0.13	9.7
4236.22	12.31	40.86	67.18	0.769	0.13	9.8
4276.95	12.19	40.96	67.68	0.771	0.13	9.9
4317.68	12.19	40.94	68.17	0.771	0.13	10.0
4358.42	12.11	41.06	68.67	0.772	0.14	10.0
4399.15	12.09	41.03	69.16	0.772	0.14	10.1
4439.88	12.06	41.10	69.65	0.773	0.14	10.2
4480.62	11.98	41.17	70.14	0.775	0.14	10.3
4521.35	11.94	41.26	70.63	0.776	0.14	10.3
4562.08	11.86	41.36	71.11	0.777	0.15	10.4
4602.81	11.75	41.54	71.59	0.779	0.15	10.5
4643.55	11.68	41.63	72.06	0.781	0.15	10.5
4684.28	11.57	41.76	72.53	0.783	0.15	10.6
4725.01	11.50	41.83	73.00	0.784	0.15	10.7
4765.75	11.38	41.98	73.47	0.787	0.15	10.7
4806.48	11.26	42.12	73.93	0.789	0.16	10.8
4847.21	11.18	42.25	74.38	0.791	0.16	10.9
4887.94	11.09	42.36	74.83	0.793	0.16	10.9
4928.68	10.98	42.47	75.28	0.795	0.16	11.0
4969.41	10.95	42.56	75.73	0.795	0.16	11.1
5010.14	10.86	42.63	76.17	0.797	0.17	11.1

5050.88	10.79	42.74	76.61	0.798	0.17	11.2
5091.61	10.73	42.83	77.04	0.800	0.17	11.3
5132.34	10.60	42.99	77.48	0.802	0.17	11.3
5173.07	10.54	43.09	77.91	0.803	0.17	11.4
5213.81	10.45	43.20	78.33	0.805	0.18	11.4
5254.54	10.40	43.23	78.76	0.806	0.18	11.5
5295.27	10.31	43.33	79.18	0.808	0.18	11.6
5336.01	10.28	43.40	79.59	0.808	0.18	11.6
5376.74	10.24	43.47	80.01	0.809	0.18	11.7
5417.47	10.16	43.54	80.43	0.811	0.18	11.8
5458.21	10.13	43.58	80.84	0.811	0.19	11.8
5498.94	10.11	43.63	81.25	0.812	0.19	11.9
5539.67	10.04	43.68	81.66	0.813	0.19	11.9
5580.40	9.993	43.77	82.07	0.814	0.19	12.0
5621.14	9.925	43.84	82.47	0.815	0.19	12.1
5661.87	9.863	43.91	82.87	0.817	0.20	12.1
5702.60	9.804	44.00	83.27	0.818	0.20	12.2
5743.34	9.749	44.07	83.67	0.819	0.20	12.2
5784.07	9.655	44.20	84.06	0.821	0.20	12.3
5824.80	9.590	44.25	84.45	0.822	0.20	12.3
5865.53	9.539	44.34	84.84	0.823	0.21	12.4
5906.27	9.500	44.39	85.23	0.824	0.21	12.5
5947.00	9.499	44.41	85.61	0.824	0.21	12.5
5987.73	9.402	44.49	86.00	0.826	0.21	12.6
6028.47	9.377	44.51	86.38	0.826	0.21	12.6
6069.20	9.385	44.54	86.76	0.826	0.21	12.7
6109.93	9.338	44.57	87.14	0.827	0.22	12.7
6150.66	9.314	44.61	87.52	0.827	0.22	12.8
6191.40	9.314	44.59	87.90	0.827	0.22	12.8
6232.13	9.293	44.61	88.28	0.828	0.22	12.9
6272.86	9.267	44.65	88.66	0.828	0.22	13.0
6313.60	9.236	44.70	89.03	0.829	0.23	13.0
6354.33	9.236	44.72	89.41	0.829	0.23	13.1
6395.06	9.179	44.77	89.78	0.830	0.23	13.1
6435.79	9.143	44.82	90.16	0.831	0.23	13.2
6476.53	9.123	44.84	90.53	0.831	0.23	13.2
6517.26	9.064	44.91	90.90	0.832	0.24	13.3
6557.99	9.015	44.99	91.26	0.833	0.24	13.3
6598.73	8.988	45.00	91.63	0.834	0.24	13.4
6639.46	8.952	45.05	91.99	0.834	0.24	13.4
6680.19	8.938	45.08	92.36	0.835	0.24	13.5
6720.93	8.922	45.11	92.72	0.835	0.24	13.6
6761.66	8.919	45.14	93.09	0.835	0.25	13.6
6802.39	8.806	45.25	93.44	0.837	0.25	13.7
6843.12	8.767	45.29	93.80	0.838	0.25	13.7
6883.86	8.724	45.35	94.16	0.839	0.25	13.8
6924.59	8.684	45.39	94.51	0.839	0.25	13.8
6965.32	8.659	45.45	94.86	0.840	0.26	13.9
7006.06	8.623	45.49	95.21	0.841	0.26	13.9
7046.79	8.596	45.54	95.56	0.841	0.26	14.0
7087.52	8.578	45.56	95.91	0.842	0.26	14.0
7128.25	8.545	45.59	96.26	0.842	0.26	14.1
7168.99	8.582	45.55	96.61	0.841	0.27	14.1
7209.72	8.512	45.63	96.96	0.843	0.27	14.2
7250.45	8.502	45.63	97.30	0.843	0.27	14.2
7291.19	8.501	45.63	97.65	0.843	0.27	14.3
7331.92	8.482	45.67	98.00	0.843	0.27	14.3
7372.65	8.448	45.72	98.34	0.844	0.27	14.4
7413.38	8.466	45.68	98.68	0.844	0.28	14.4
7454.12	8.440	45.70	99.03	0.844	0.28	14.5
7494.85	8.408	45.74	99.37	0.845	0.28	14.5
7535.58	8.380	45.76	99.71	0.845	0.28	14.6
7576.32	8.423	45.74	100.1	0.844	0.28	14.6
7617.05	8.408	45.74	100.4	0.845	0.29	14.7
7657.78	8.373	45.77	100.7	0.845	0.29	14.7
7698.52	8.397	45.77	101.1	0.845	0.29	14.8
7739.25	8.364	45.76	101.4	0.845	0.29	14.8

7779.98	8.361	45.80	101.8	0.846	0.29	14.9
7820.71	8.327	45.83	102.1	0.846	0.30	14.9
7861.45	8.318	45.83	102.4	0.846	0.30	15.0
7902.18	8.293	45.87	102.8	0.847	0.30	15.0
7942.91	8.278	45.89	103.1	0.847	0.30	15.1
7983.65	8.255	45.91	103.5	0.848	0.30	15.1
8024.38	8.242	45.91	103.8	0.848	0.30	15.2
8065.11	8.222	45.94	104.1	0.848	0.31	15.2
8105.84	8.251	45.90	104.5	0.848	0.31	15.3
8146.58	8.213	45.94	104.8	0.848	0.31	15.3
8187.31	8.201	45.95	105.1	0.849	0.31	15.4
8228.04	8.180	45.96	105.5	0.849	0.31	15.4
8268.78	8.138	46.03	105.8	0.850	0.32	15.5
8309.51	8.081	46.08	106.1	0.851	0.32	15.5
8350.24	8.042	46.13	106.4	0.852	0.32	15.6
8390.97	8.040	46.15	106.8	0.852	0.32	15.6
8431.71	7.992	46.21	107.1	0.853	0.32	15.7
8472.44	7.978	46.24	107.4	0.853	0.33	15.7
8513.17	7.961	46.26	107.8	0.853	0.33	15.7
8553.90	7.961	46.27	108.1	0.853	0.33	15.8
8594.63	7.922	46.31	108.4	0.854	0.33	15.8
8635.37	7.892	46.35	108.7	0.854	0.33	15.9
8676.10	7 847	46.41	109.0	0.855	0.33	15.9
8716.83	7.859	46.41	109.4	0.855	0.34	16.0
8757.56	7.807	46.48	109.7	0.856	0.34	16.0
8798.30	7.814	46.47	110.0	0.856	0.34	16.1
8839.03	7.728	46.56	110.3	0.858	0.34	16.1
8879.76	7.681	46.60	110.6	0.858	0.34	16.2
8920.49	7.669	46.65	110.9	0.859	0.35	16.2
8961.23	7.598	46.74	111.2	0.860	0.35	16.3
9001.96	7.558	46.80	111.6	0.861	0.35	16.3
9042.69	7.490	46.88	111.9	0.862	0.35	16.3
9083.42	7.425	46.96	112.2	0.863	0.35	16.4
9124.16	7.383	47.03	112.5	0.864	0.36	16.4
9164.89	7.304	47.11	112.8	0.866	0.36	16.5
9205.62	7.281	47.17	113.1	0.866	0.36	16.5
9246.35	7.167	47.30	113.3	0.868	0.36	16.6
9287.09	7.109	47.38	113.6	0.870	0.36	16.6
9327.82	7.038	47.46	113.9	0.871	0.36	16.6
9368.55	6.969	47.54	114.2	0.872	0.37	16.7
9409.28	6.908	47.61	114.5	0.873	0.37	16.7
9450.02	6.883	47.66	114.8	0.874	0.37	16.8
9490.75	6.822	47.73	115.0	0.875	0.37	16.8
9531.48	6.792	47.76	115.3	0.875	0.37	16.9
9572.21	6.769	47.79	115.6	0.876	0.38	16.9
9612.95	6.766	47.82	115.9	0.876	0.38	16.9
9653.68	6.712	47.83	116.1	0.877	0.38	17.0
9694.41	6.685	47.89	116.4	0.878	0.38	17.0
9735.14	6.664	47.94	116.7	0.878	0.38	17.1
9775.88	6.636	47.95	117.0	0.878	0.39	17.1
9816.61	6.619	47.99	117.2	0.879	0.39	17.1
9857.34	6.594	48.03	117.5	0.879	0.39	17.2
9898.07	6.573	48.05	117.8	0.880	0.39	17.2
9938.80	6.537	48.10	118.0	0.880	0.39	17.3
9979.54	6.527	48.13	118.3	0.881	0.39	17.3
10020.27	6.454	48.20	118.6	0.882	0.40	17.3
10061.00	6.461	48.22	118.8	0.882	0.40	17.4
10101.73	6.383	48.31	119.1	0.883	0.40	17.4
10142.47	6.364	48.35	119.3	0.884	0.40	17.4
10183.20	6.312	48.41	119.6	0.885	0.40	17.5
10223.93	6.251	48.48	119.9	0.886	0.41	17.5
10264.66	6.199	48.54	120.1	0.887	0.41	17.6
10305.40	6.152	48.62	120.4	0.888	0.41	17.6
10346.13	6.093	48.68	120.6	0.889	0.41	17.6
10386.86	6.033	48.75	120.9	0.890	0.41	17.7
10427.59	5.995	48.81	121.1	0.891	0.42	17.7
10468.33	5.917	48.88	121.3	0.892	0.42	17.7

10509.06	5.851	48.95	121.6	0.893	0.42	17.8
10549.79	5.842	48.98	121.8	0.893	0.42	17.8
10590.52	5.774	49.06	122.1	0.895	0.42	17.8
10631.26	5.751	49.09	122.3	0.895	0.42	17.9
10671.99	5.705	49.15	122.5	0.896	0.43	17.9
10712.72	5.668	49.19	122.7	0.897	0.43	17.9
10753.45	5.624	49.23	123.0	0.897	0.43	18.0
10794.19	5.607	49.27	123.2	0.898	0.43	18.0
10834.92	5.581	49.29	123.4	0.898	0.43	18.0
10875.65	5.541	49.33	123.7	0.899	0.44	18.1
10916.38	5.519	49.36	123.9	0.899	0.44	18.1
10957.12	5.518	49.39	124.1	0.900	0.44	18.1
10997.85	5.456	49.42	124.3	0.901	0.44	18.2

TOTAL PATTERN RESULTS:

WATERFLOOD RECOVERY :	847.78	MSTB
WATERFLOOD+INFILL RECOVERY :	994.64	MSTB
INCREMENTAL OIL FROM INFILL:	146.87	MSTB
INCREMENTAL OIL FROM INFILL:	2.68	% OOIP
ORIGINAL OIL IN PLACE :	5474.04	MSTB

APPENDIX 3a
SPE REFERENCE PAPER FOR IDPM SENSITIVITY ANALYSIS

SPE 22333

Screening Waterfloods for Infill Drilling Opportunities

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Abstract

Infill drilling is now recognized as a viable improved recovery process. However, the reliable prediction of incremental recovery by infill drilling cannot be readily and accurately determined by present techniques.

As an alternate approach, A DOE sponsored infill drilling predictive model (IDPM) was evaluated. Its performance was improved by adjusting some of its key parameters based on the comparison of actual field recoveries with model results.

Also discussed in the paper is the sensitivity of infill recovery to areal and vertical heterogeneities. Also highlighted is the importance of applying remedial techniques is highlighted, such as near well plug backs and in-depth mobility control upon the recovery efficiency.

Introduction - Concept

Infill drilling for acceleration and incremental recovery has been a common industry practice for many years. The infill drilling opportunity exists in all stages of development: primary, secondary, and tertiary. However, determining if the opportunity can be economically realized is no simple task. Previous approaches have involved overly simple streamtube models, or overly complex 3-D numerical simulators combined with separate economic analysis.

Recognizing this problem, the U.S. Department of Energy has recently created a "Predictive Model" for infill drilling of waterflood projects. This model uses a minimum amount of reservoir and geologic description to determine if an existing waterflood project would benefit from infill drilling. The predictive model is a hybrid between streamtube and numerical simulators, and provides fast, accurate predictions of waterflood infill behavior. The resulting performance prediction is combined with estimates of capital and operating cost to determine a discounted economic assessment of a proposed project. In this way, both acceleration and incremental recovery effects can be accounted for when screening several opportunities.

The purpose of this paper is to determine if the IDPM can be used to screen for infill drilling opportunities. The use of a screening model implies acceptance of major assumptions in the formulation of the model. Since the model is only being used to determine which projects are economically better than others, it does not require a full field simulation, but assumes instead that a pattern element is representative of average reservoir behavior. However, we must be satisfied that the principal recovery mechanisms in the process are correctly simulated. A comparison should be made with an existing project to identify parameters that are sensitive and what mechanisms accurately model real behavior.

Although the predictive model matches ideal reservoir behavior under a controlled set of assumptions, it has some difficulty matching actual project performance. By comparing model behavior to actual field performance, we have determined the key factors required to make such a predictive model suitable for screening studies.

In infill drilling projects in West Texas, incremental recovery in carbonates has been attributed primarily to improved continuity between wells, and therefore more net pay contacted by the flood. During the analysis of one typical waterflood, the North Riley Unit, we discovered that both sweep efficiency and improved continuity play major roles due to the highly heterogeneous nature of the reservoir. Furthermore, through the analysis of the results, it became apparent that near well plug backs by a process such as crosslinked polymer gel injection, or in-depth mobility and permeability variation control by a process such as Mobility Controlled Caustic Flood (MCCF), could result in a significant additional recovery.

Infill Drilling Predictive Model (IDPM)

The Infill Drilling Predictive Model (IDPM) has a similar design to that of the other DOE predictive models:

1.	Polymer flooding	(DOE/BC - 86/10/SP)
2.	Chemical flooding	(DOE/BC - 86/11/SP)
3.	CO_2 miscible flooding	(DOE/BC - 86/12/SP)
4.	Steam flooding	(DOE/BC - 86/6/SP)
5.	Insitu Combustion	(DOE/BC - 86/7/SP)

This model is a specialized model for waterflood patterns, and incorporates several recovery mechanisms:

1. Improved reservoir continuity
2. Improved areal sweep
3. Improved vertical sweep
4. Cross flow between layers
5. Plug back at infill of thief zones

These mechanisms are stimulated to provide production and recovery forecasts for continued waterflood and infill cases. These production forecasts, consisting of oil and water rate versus time, are then passed to an economic module for individual and incremental economics. Data for drilling and completion, injection, operating cost, and a pattern schedule (to simulate field-wide development) allow the computation of before and after tax discounted cash flow. By comparing the infill project to continued waterflood, the incremental economic profitability criteria used for screening are computed, such as DCFROR and Profit to investment ratio.

The IDPM is a hybrid between streamtube and numerical simulators, and provides fast, accurate predictions of waterflood infill behavior. The IDPM assumes that streamtubes do not change shape with water cut, and that the streamtubes are independent of mobility ratio. The IDPM is a three-dimensional two-phase simulator of a waterflood pattern element which is made up of a collection of two-dimensional slices for each streamtube. Each streamtube slice allows cross flow between layers and tracks oil and water fluid movements using a finite difference simulation. FIGURE 1 shows the streamtubes for typical conditions in 5 to 5-spot and 5 to 9-spot pattern elements before and after infill.

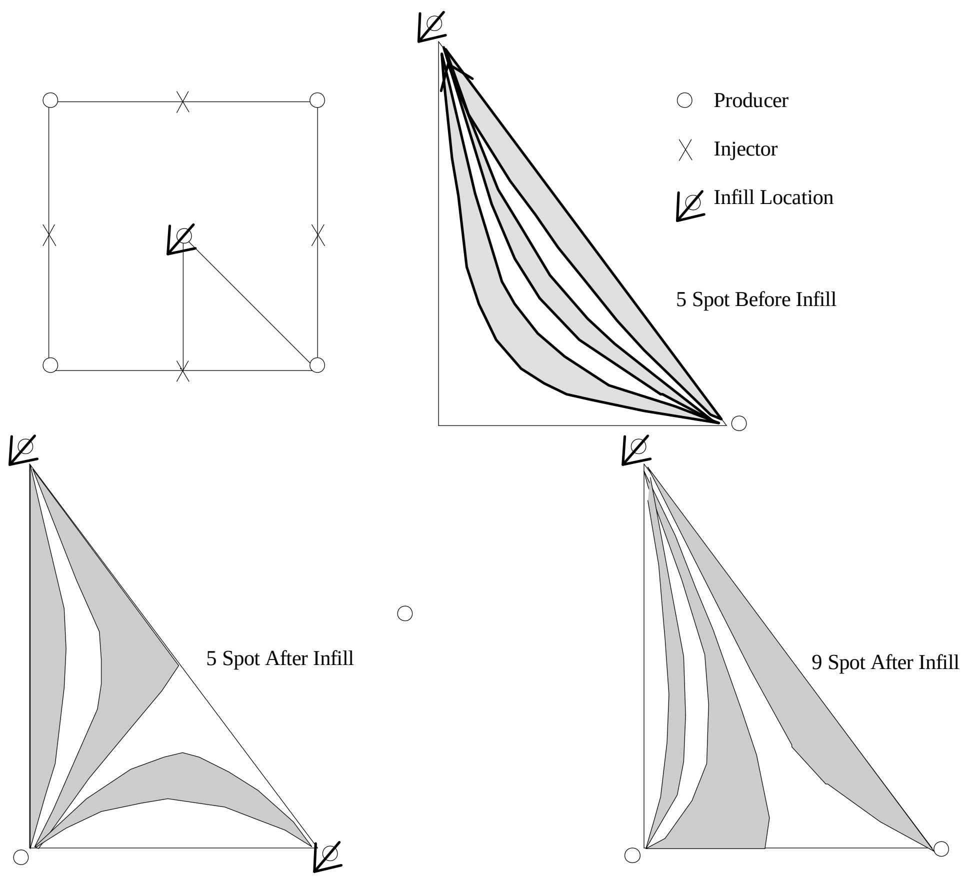


Figure 1. -- Before and After Infill Configurations

Streamtube shapes are computed based upon a steady-state pressure solution before and after infill using the anisotropy ratio Ky/Kx to approximate areal heterogeneity. The saturations at the infill point are mapped into the new streamtubes at infill with material balance preserved. Vertical heterogeneity is modeled by assigning layer permeability using the Dykstra-Parsons[1] coefficient (Vdp). The IDPM allows the user to optionally apply plug backs at the infill point to control thief zones simulating near well profile control by a water shutoff process.

Reservoir continuity is modelled by adjusting the relative permeability curves before and after infill. These curves are determined from Corey-type equations based upon end point values:

$$Uo = (1.0 - Sw - Sorw) / (1.0 - Swc - Sorw) \quad (1)$$
$$Kro = Kroe * Uo^{Xno} \quad (2)$$
$$Uw = (Sw - Swc) / (1.0 - Swc - Sorw) \quad (3)$$
$$Krw = Krwe * Uw^{Xnw} \quad (4)$$

Continuity (C), or connectivity, of 100 percent is assumed to be represented by laboratory relative permeability measurements. Under field conditions with lower continuity, the residual oil saturation due to water flood (Sorw) is adjusted linearly:

$$Sorw_{used} = C * Sorw + (1.0 - C) * (1.0 - Soi) \quad (5)$$

This means that at zero continuity, Sorw would equal (1.0 - Soi) and no recovery would occur due to waterflood. As a default, each layer used Soi equal to Swc. However, if a primary recovery is specified, then Soi in each layer is adjusted according to Vdp, assuming that the most productive layers will be the greatest depleted. The relative permeabilities in Eqn's 2 and 4 are then computed before and after infill based upon Sorw which is tied to continuity by Eqn 5.

Continuity in turn is tied to well spacing assuming a semi-log relationship allowing 100 percent continuity at a finite well spacing. The IDPM computes the distance down each streamtube and then determines a unique relative permeability relationship, based on continuity for each tube.

PROJECT COMPARISONS

1. North Riley Field Description

The North Riley Unit is located 12 miles west of Seminole, Texas in Gaines County. The unitized interval extends from 50 feet above the top of the Upper Clearfork to 300 feet below the top of the Lower Clearfork. The North Riley Field was unitized in December of 1976. Secondary recovery operations were implemented in the north end of the Unit with the beginning of water injection in July of 1977. Water was injected into 9 wells on an inverted 9-spot pattern. The inverted 9-spot pattern was expanded to cover the central and south portions of the unit, with a total of 18 injection wells active by 1980. In 1982, the injection pattern was changed to an 80-acre 5-spot pattern with the conversion to injection of an additional 21 wells.

The nature of the reservoir is such that the wells will not produce without fracture treating, either large acid fracture treatments or propped gelled water fracture treatments. Since the injectors were the original 40-acre producers, all have been fracture treated. However, the injectors are subject to severe scaling and this tends to unbalance the patterns over time. IDPM does not included this effect, therefore the input permeability was adjusted to match flow capacity of wells.

In 1984 increased densification was begun with the drilling of 20 acre infill wells. This converted the pattern from 80-acre 5-spot patterns to inverted 9-spot patterns. The increased densification continued through 1987 with 91 20-acre infill wells drilled. Production increased from 1375 BOPD to a peak production of 4150 BOPD. With the increased fluid production from the densification, the injection to withdrawal ratio dropped below one in the major productive area of the field. In February of 1988, selected producers were converted to water injection service. This conversion project changed the 80-acre inverted 9-spot pattern to a 40-acre 5-spot pattern. These conversions increased injection from 12,500 BWPD to in excess of 26,000 BWPD.

In the second quarter of 1990, the North Riley Unit initiated a 10-acre infill drilling project consisting of 5 wells in a North study are and 5 wells in a South study area as shown on FIGURE 2. These 10-acre locations have been completed for potentials ranging from 365 BOPD to 90 BOPD. The average IP for the 10 wells is 180 BOPD. Prior to 10-acre infill drilling, the injection to withdrawal ratio in the two study area was approximate 4:1. Following the infill drilling, the increased fluid withdrawals dropped the injection to withdrawal ratio to approximately one.

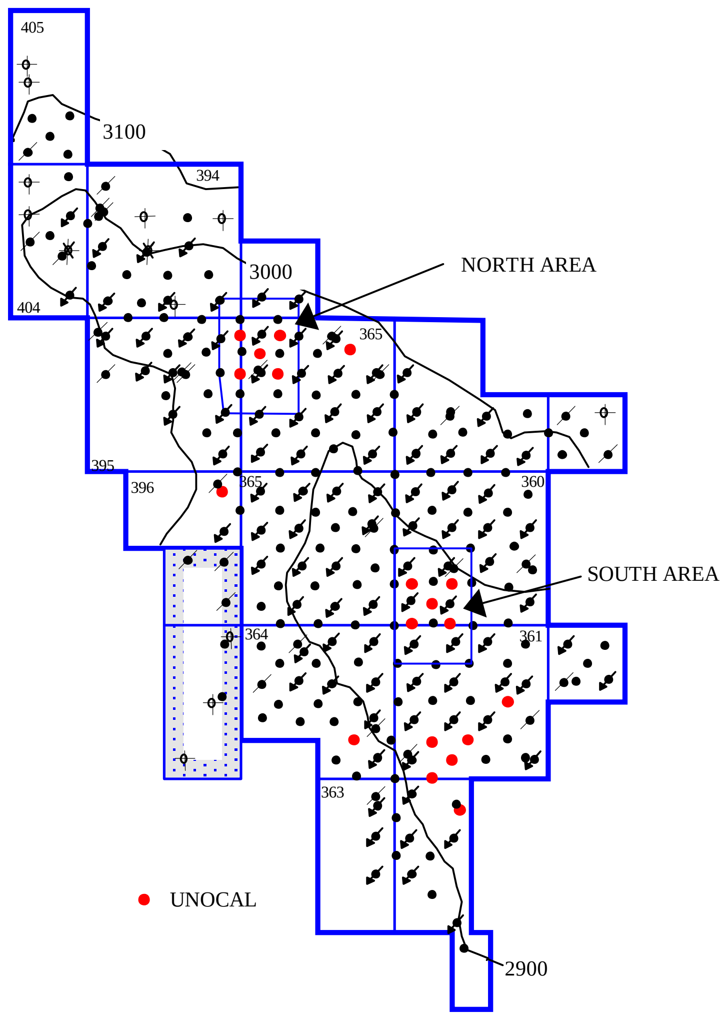


Figure 2 -- NORTH RILEY UNIT -- Upper Clear Fork

2. Geologic Setting

The North Riley Unit is on the northern portion of a north westward gently plunging anticline. FIGURE 3 shows a three well cross section in the North Area. This stratified dolomite has a gross interval open for production in the unit covering about 1000 feet and is divided into at least 11 productive zones. As seen in the cross section, the reservoir is divided into numerous stringers that are difficult to correlate and can vary in thickness and quality from one location to the next, as well as disappear. Within the gross interval there are more than 100 beds or lenses that have widely varying permeability, porosity, thickness, water saturation, and connectivity to neighboring wells.

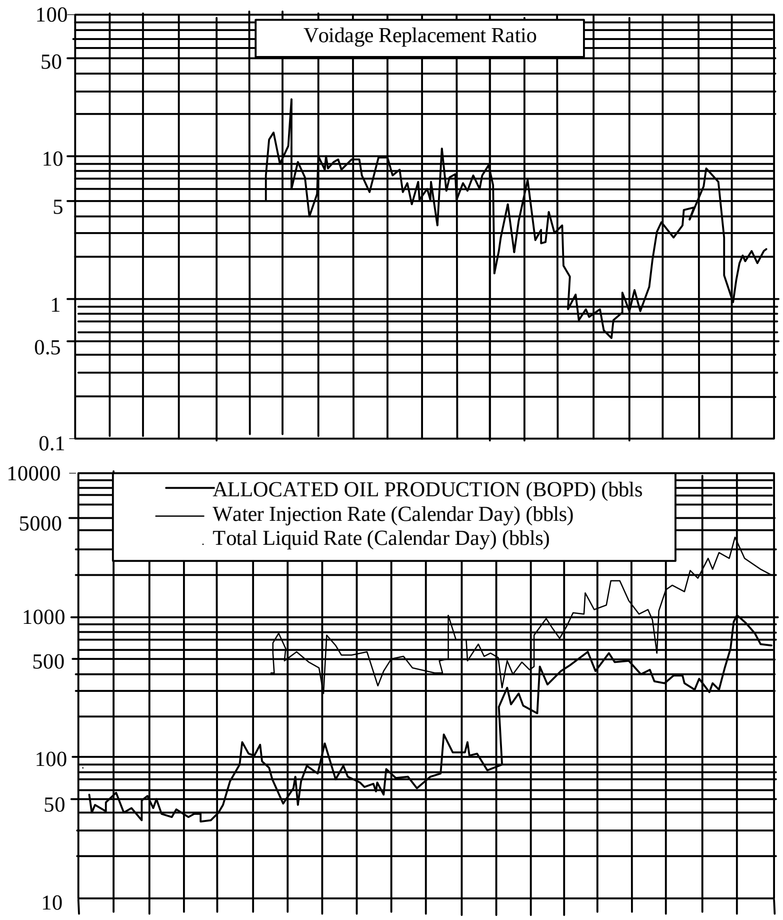


Figure 3 -- NORTH STUDY AREA

Core data has been taken from the central 200 feet of the interval in several wells. This data confirms high heterogeneity with wide scatter on the traditional porosity-permeability cross plots. However, Dykstra-Parsons plots of the permeability distribution seem well behaved with at least two rock types present. The higher permeability beds have a different slope than the lower permeability beds The average slopes from several wells range from 0.71 to 0.91.

Continuity is a major factor in the success of infill drilling. However, it is very difficult to determine, and subject to interpretation. The most prevalent method to determine this factor is to use a cross section, such as FIGURE 3, and determine which beds or lenses connect between wells and which do not. Clearly, each interpreter will determine a different answer which will be subject to change as information from infill wells becomes available.

In order to provide continuity values to the IDPM, we established low (45%), most likely (55%) and high (65%) values at 20 acre well spacing. We also estimated that 100% continuity would occur at 300 foot well spacing. The resulting continuity would occur at 300 foot well spacing. The resulting continuity diagram for North Riley is shown in FIGURE 4. This means that a well with 55% continuity at 20 acre spacing will improve to 71% at 10 acres. Similarly, a well with 45% continuity at 20 acre spacing will improve to 63% at 10 acres.

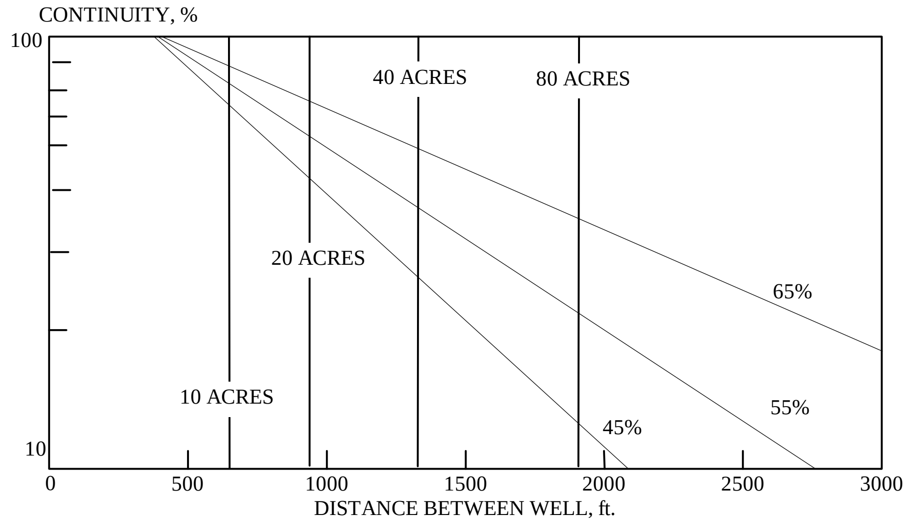


Figure 4 -- Continuity -- North Riley

TABLE 1 shows the average reservoir properties that were used to initialize IDPM for the North Riley Unit. Laboratory tests to date for relative permeability show a wide variation of behavior. However, the initial saturation at connate water (Swc = 0.32) seems to be fairly consistent. The residual oil saturation to water shows some variation, and we selected Sorw = 0.25 as a reasonable average.

TABLE 1
GENERAL RESERVOIR PROPERTIES USED IN PREDICTIVE MODEL

AVERAGE DEPTH	6300 FEET
FORMATION TEMP	607 DEG F
DYKSTRA-PARSONS COEF.	.83 VDP
PRESSURE AT FORMATION TOP	2750 PSIA
OIL GRAVITY	32.0 DEG API
OIL FVF	1.285
OIL VISC. AT RES. COND.	1.70 CP
SOLUTION GAS-OIL RATIO	330 SCF/STB
IRREDUCIBLE WATER SATURATION	.32
RESIDUAL OIL SATURATION	.25

3. North Riley - North Area

Reservoir Description

The North Area has better primary recovery and better flow capacity than the South Area as shown in TABLE 2. The porosity-feet (ϕh) in the North Area varies widely from 18 to 50 within the 240 acre area. However, with an average of 35.4, we can estimate the original oil in place in the North Area as follows:

$$OOIP = 7758 * (\phi h) * Soi * A / Bo \qquad 6$$

Thus,

$$OOIP = 7758 * 35.4 * 0.68 * 240 / 1.28$$

$$OOIP = 35.0 \text{ MMBO}$$

TABLE 2
NORTH RILEY RESERVOIR DATA

	NORTH STUDY AREA	SOUTH STUDY AREA
AVE. NET PAY	447 FEET	266 FEET
RATIO OF GROSS/NET PAY	1.43	2.45
AVE. POROSITY	7.0	7.0
CALC. OOIP	35 MMBO	19.5 MMBO
% PRIMARY RECOVERY	7.9%	4.5%
% CUM PROD AT 6/90	11.4%	7.2%
% WATER CUT BEFORE INFILL	39.2%	49.3%
WATER CUT AT INFILL	72.0%	55.0%

Performance Before/After Infill

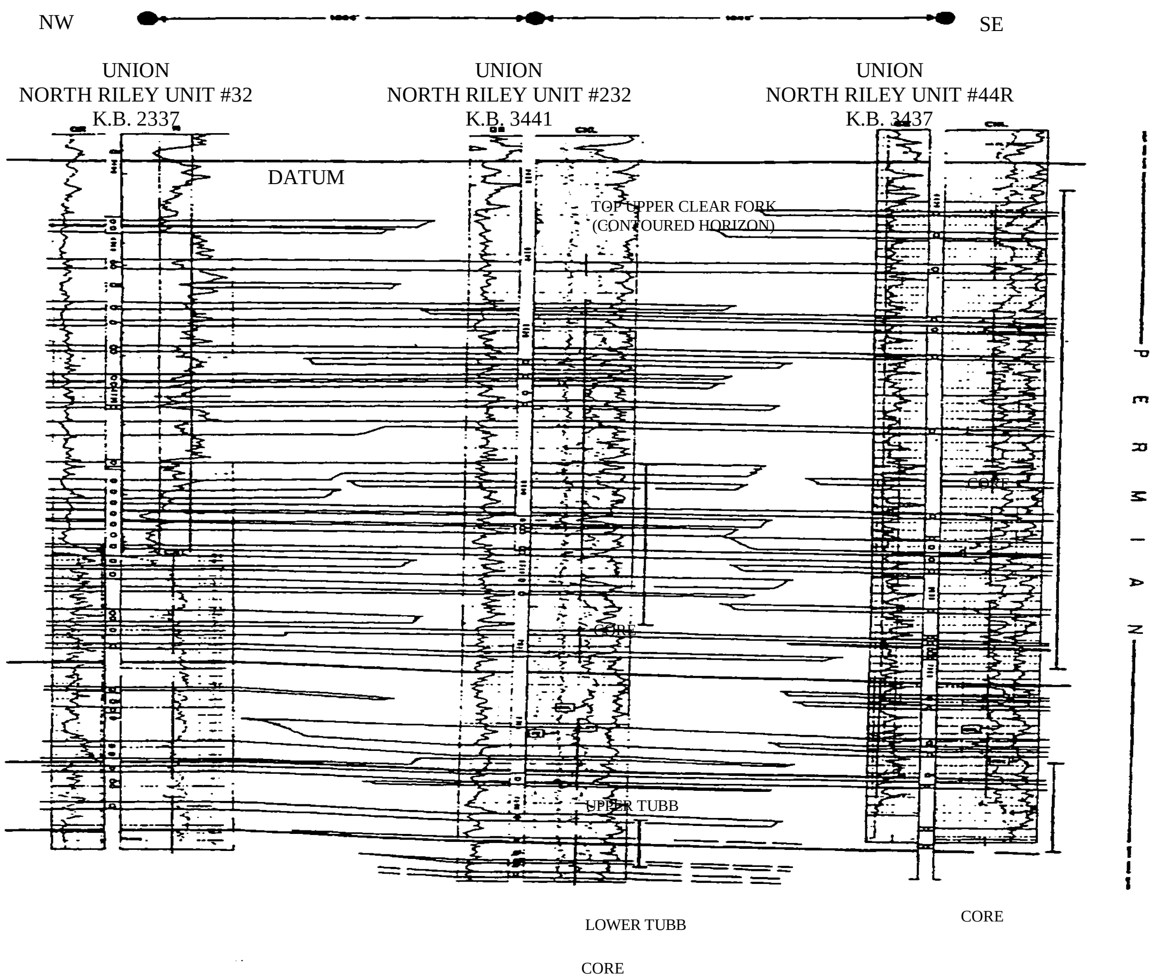


Figure 5 -- NORTH RILEY UNIT STRATIGRAPHIC

FIGURE 5 shows the historical behavior of the wells in the North Area. The voidage ratio is higher than 1.0 during fillup, as expected. Prior to the 10 acre infill program, the voidage ratio reached a high of 5, due to unbalanced injection. After the infill program, the ratio begins to approach one. The data is transformed to a cumulative oil basis on FIGURE 6, in order to show the behavior of oil cut and recovery before and after infill. Using the estimated OOIP as a basis, the primary recovery in this area is 7.9%, and the cumulative recovery prior to 10 acre infill was 11.4%. The average water cut at the beginning of infill 39%. Immediately after infill, the water cut increased to 72% Notice on FIGURE 6 that the oil cut increases with increasing voidage ratio just prior to infill. We cannot explain this behavior, but believe that it is a sweep related phenomenon.

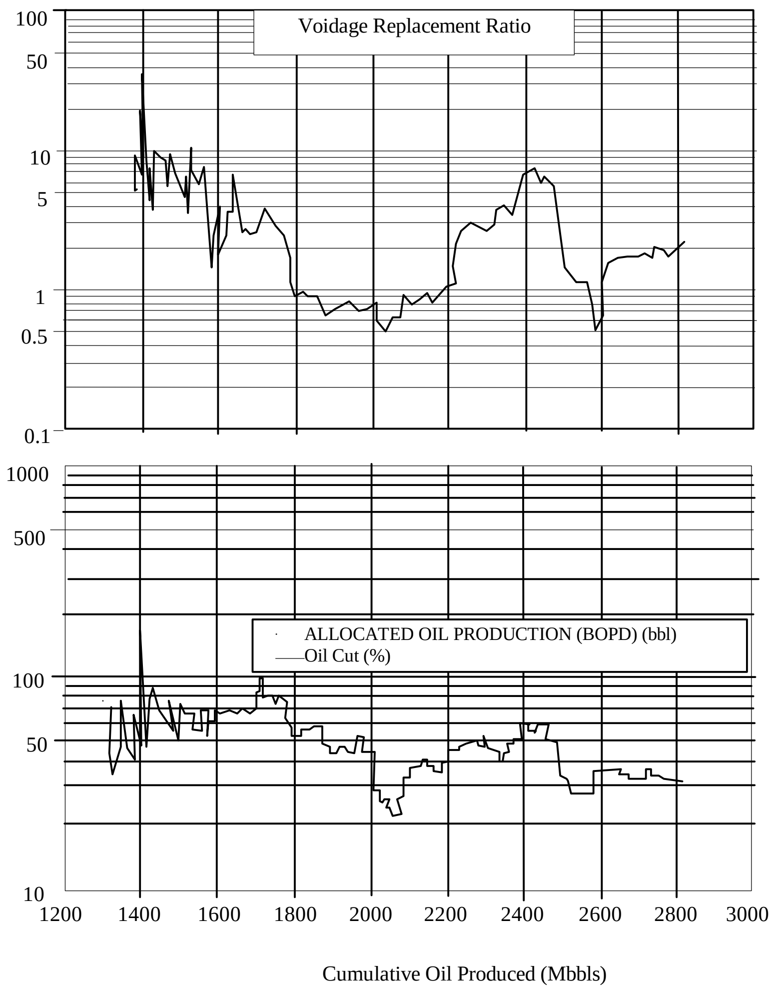


Figure 6 -- NORTH STUDY AREA

One of the most interesting aspects of the North Area was revealed when we performed a classical streamline calculation using total rates for the gross interval. For this purpose, a classical streamline program was used because IDPM cannot handle the entire field. FIGURE 7 shows the streamlines before infill (June 1990) and FIGURE 8 shows the streamlines after infill (December 1990). The 1000 series well numbers indicate wells in 10-acre locations. Examination of the streamlines associated with well no. 44-R, shows that injection was going in a predominately westerly direction. Following the drilling of the infill wells, the streamlines changed such that the injection into well no. 44-R, shows that injection was going in a predominately westerly direction. Following the drilling of the infill wells, the streamlines changed such that the injection into well no. 44-R is more evenly distributed. This better distribution of injected water will result in better sweep efficiency in several areas, as shown on FIGURE 8.

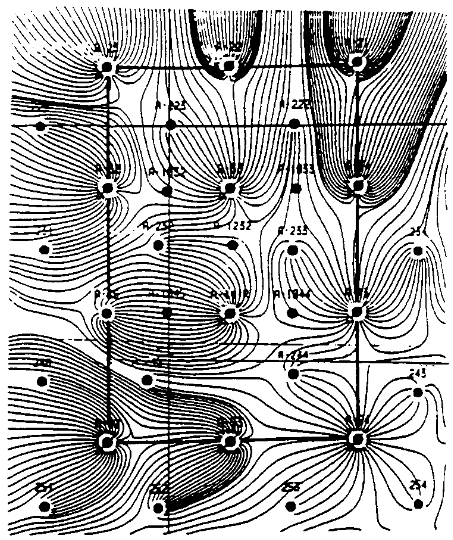


Figure 7 -- NORTH AREA STREAMLINES PRIOR TO INFILL

Although individual zones or beds will have greatly different streamline behavior depending on flow capacity and connectivity, the overall average performance of the streamlines shows that, even in an ideal reservoir, the patterns are not well balanced before infill. This means that areal sweep efficiency will be low. After infill, with improved pattern balancing, areal sweep efficiency will increase, as shown in FIGURE 8. The true location of streamlines and the actual improvement in area sweep is impossible to determine due to the vertical and areal heterogeneities of the reservoir.

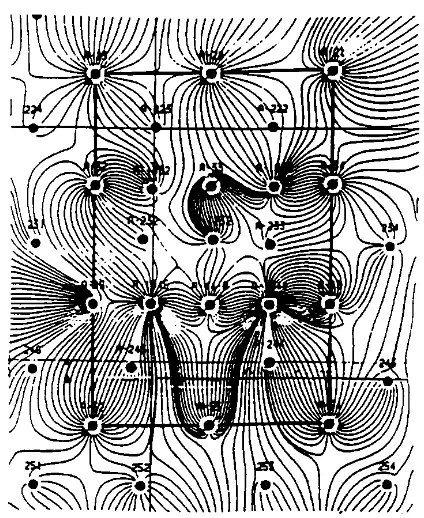


Figure 8 -- NORTH AREA STREAMLINES AFTER INFILL

Comparison with IDPM

The infill pattern in the North Area is part way between a 5-spot and a 9-spot. The final development plan is to complete the drilling as 9-spots, but during the period of comparison, it would be reasonable to expect behavior somewhere between that of true 5-spot and true 9-spot.

In order to provide a basis of comparison with actual reservoir performance, we have shown the forecast used for AFE justification prior to infill and the actual behavior after infill. FIGURE 9 shows the IDPM predictions for a 5 to 5-spot infill project. FIGURE 10 shows the IDPM predictions for a 5 to 9-spot infill project.

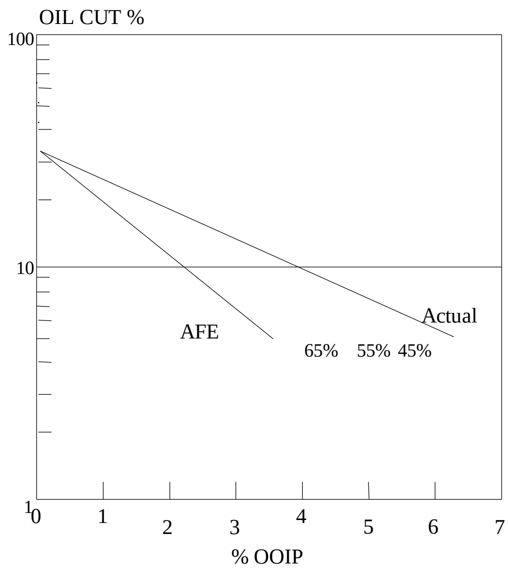


Fig. 9 - NORTH AREA IDPM PERFORMANCE
5 to 5-spot

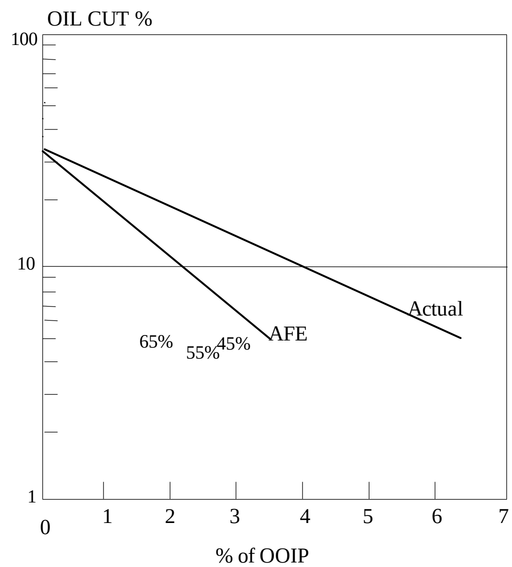


Fig. 10 - NORTH AREA IDPM PERFORMANCE
5 to 9-spot

4. North Riley - South Area

Reservoir Description

The South Area has less primary recovery and worse flow capacity than the North Area as shown in Table 2. The porosity-feet (ϕh) in the South Area varies widely from 9 to 25 within the 240 acre area. However, with an average of 19.7, we can estimate the original oil in place in the South Area as using Eqn 6:

OOIP = 7758 * 19.7 * 0.68 * 240 / 1.28

OOIP = 19.5 MMBO

Performance Before/After Infill

FIGURE 11 shows the historical behavior of the wells in the South Area. The voidage ratio is higher than 1.0 during fillup, as expected. Prior to the 10 acre infill program, the voidage ratio reached a high of 4, due to unbalanced injection. After the infill program, the ratio begins to approach one. The data is transformed to a cumulative oil basis on FIGURE 12, in order to show the behavior of oil cut and recovery before and after infill. Using the estimated OOIP as a basis, the primary recovery in this area is 4.5%, and the cumulative recovery prior to 10 acre infill was 7.2%. These recoveries are about half of the North area, and are attributable to several factors; lower flow capacity, lower sweep efficiency, higher heterogeneity and lower continuity. The average water cut at the beginning of the infill was 49%. Immediately after infill, the water cut increase to 55%. Just as in the North Area, FIGURE 12 shows that the oil cut increases with increasing voidage ratio.

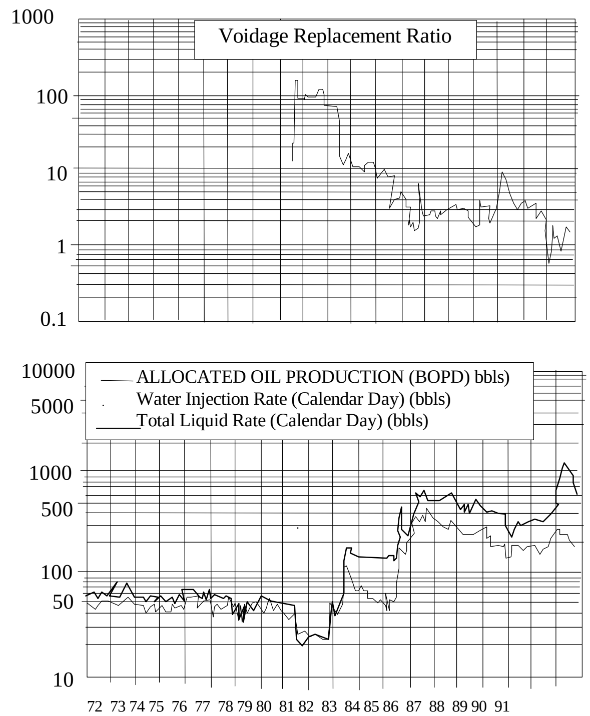


Figure 11 -- SOUTH STUDY AREA

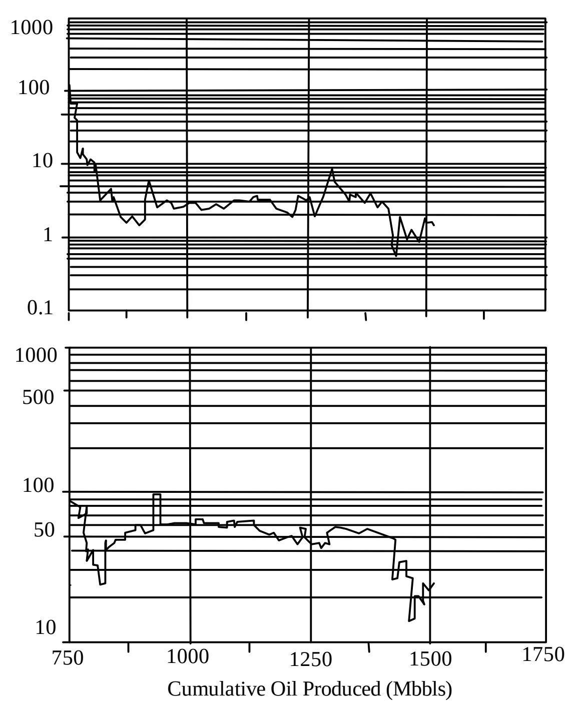


Figure 12 -- SOUTH STUDY AREA

The classical streamline calculations for the South Area also showed very interesting results. FIGURE 13 shows the streamlines before infill (June 1990) and FIGURE 14 shows the streamlines after infill (March 1991). As in the North Area the 5-spot waterflood patterns are not well balanced before infill. This means that areal sweep efficiency will be low. After infill, with improved pattern balancing, areal sweep efficiency will increase, as shown in FIGURE 14. Again, examination of the area around well no. 104-R, before and after infill, the improvement in sweep efficiency is evident. The true location of streamlines and the actual improvement in areal sweep is impossible to determine due to the vertical and areal heterogeneities of the reservoir.

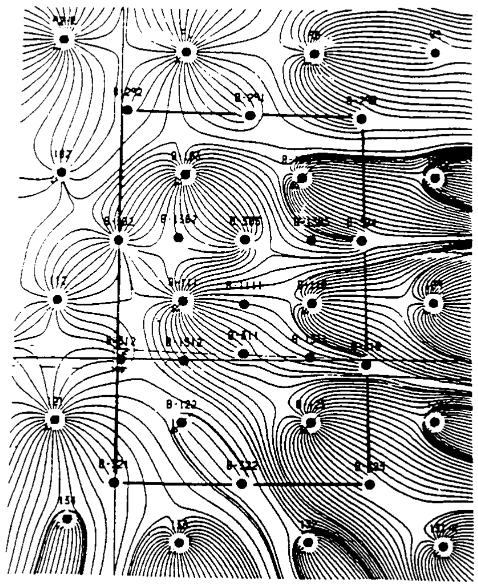


Figure 13 -- SOUTH AREA STREAMLINES PRIOR TO INFILL

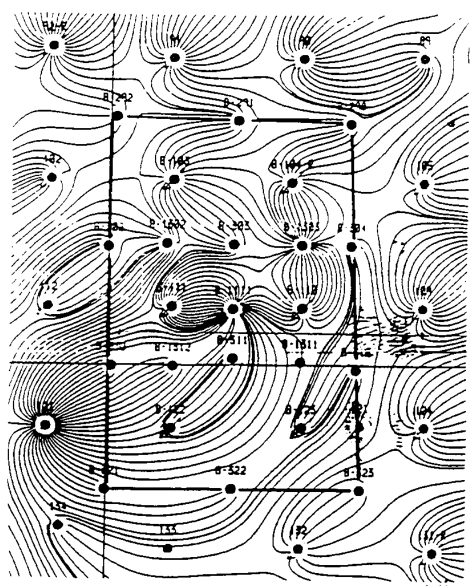


Figure 14 -- SOUTH AREA STREAMLINES AFTER INFILL

Comparison with IDPM

The infill pattern in the South Area is part way between a 5-spot and a 9-spot. The final development plan is to complete the drilling as 9-spots, but during the period of comparison, it would be reasonable to expect behavior somewhere between that of true 5-spot and true 9-spot.

In order to provide a basis of comparison with actual reservoir performance, we have shown the forecast used for AFE justification prior to infill and the actual behavior after infill project. FIGURE 15 shows the IDPM predictions for a 5 to 5-spot infill project. FIGURE 16 shows the IDPM predictions for a 5 to 9-spot infill project.

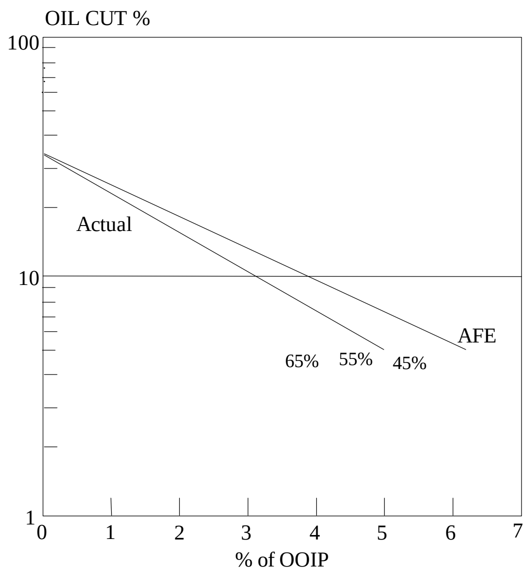


Figure 15 - SOUTH AREA IDPM PERFORMANCE
5 to 5-spot

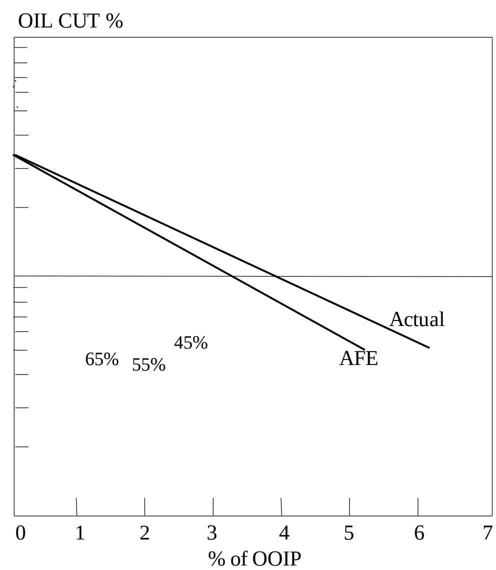


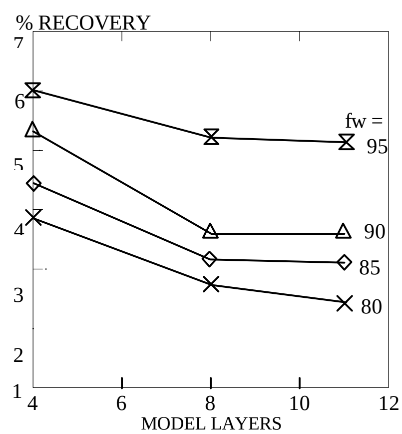
Figure 16 -- SOUTH AREA IDPM PERFORMANCE
5 to 9-spot

5. Recovery Sensitivities

Layer Sensitivity

The IDPM was found to be moderately sensitive to the number of layers used to describe the reservoir. FIGURE 17 shows the behavior of predicted incremental recovery for the case of 5-spot to 5-spot infill. As the water increases, so does the general level of incremental recovery. As the layers increase, the recovery prediction decreases and levels out at about eight layers. We used 11 layers in the North Riley comparison cases, in order to better match the known geologic setting.

Figure 17
LAYER SENSITIVITY 5-SPOT TO 5-SPOT
c=55% AT 20 acres & Infill Water Cut = 75%



Areal and Vertical Sweep Sensitivity

Anisotropy (Ky/Kx) or directional permeability was used in IDPM as a method to simulate the effects of area heterogeneity of areal sweep. The Dykstra-Parsons coefficient (Vdp) was used to distribute layer permeabilities, with the maximum in the center, as a method to simulate the effects of vertical heterogeneity on vertical sweep. We found that these effects were interrelated as shown on FIGURE 18. These results are consistent with previous numerical simulation results (2,3).

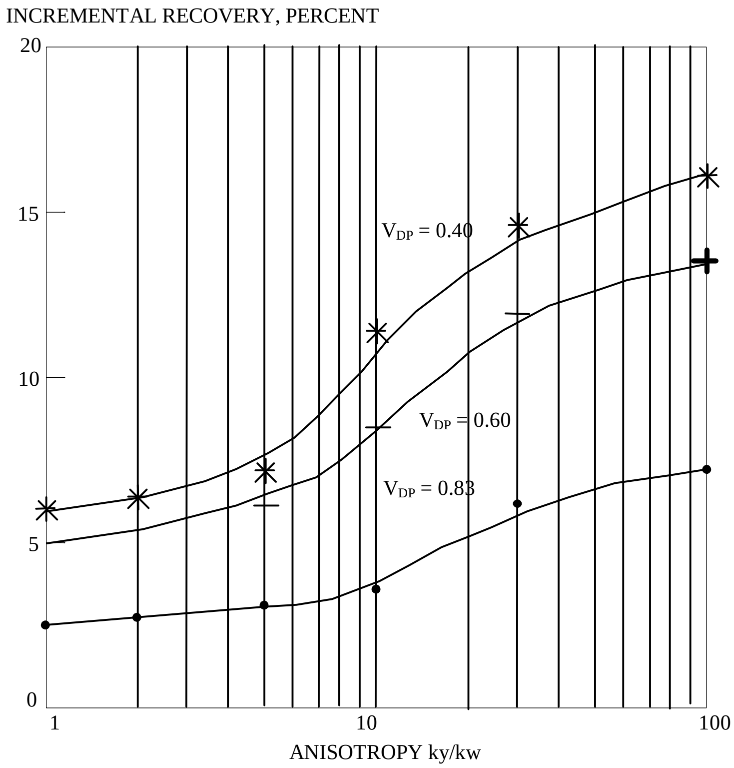


Figure 18 -- SENSITIVITY OF AREAL & VERTICAL SWEEP

As high Vdp, the effects of anisotropy on areal sweep was washed out by the thief zones with high permeability taking all the flow. At low Vdp, the influence of anisotropy is much more pronounced. It is also apparent that at lower levels of Ky/Kx, anisotropy has little effect on areal sweep as measured by incremental recovery.

FIGURE 18 also reveals that the influence of Vdp on recovery at any given Ky/Kx value is very non-linear. At higher Vdp, thief zones dominate before and after infill behavior. At lower Vdp, the layers have more uniform flow capacity, and cross flow between layers tends to make different levels of Vdp behave more equally. We used a ratio of vertical to horizontal permeability throughout this study of 0.1, as indicated by core data, which promotes high cross flow between layers.

Plug Back at Infill Sensitivity

The IDPM model allows the infill well to plug back the thief zones at infill. We found that this improves the incremental recovery and stretches out the project. FIGURE 19 shows the improved oil cut versus incremental recovery predicted by IDPM for the North Area as can be done by a crosslinked polymer gel process. The plug backs were performed in the two most productive, and highest water cut, zones. High cross flow between layers allowed the injected water to sweep layers above and below the central thief zones resulting in improved vertical sweep.

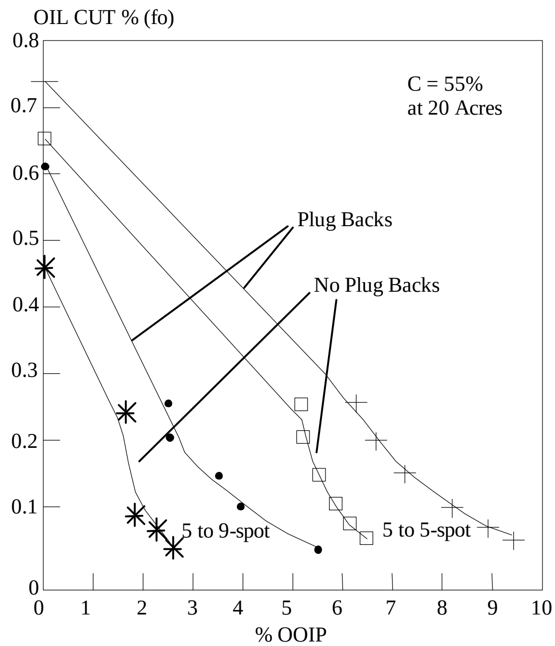
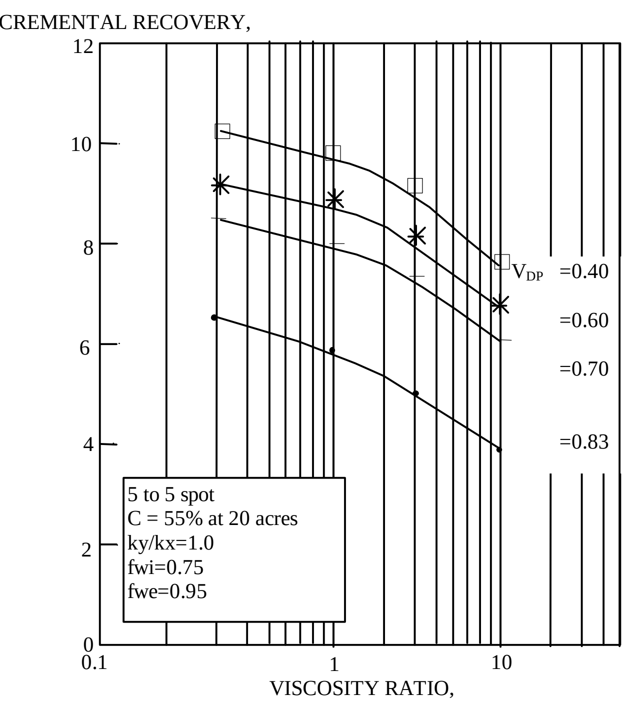


Figure 19 -- IDPM PLUG BACK SENSITIVITY

Sensitivity to Improvement of Mobility Ratio and Vdp

the IDPM model allows the variation of viscosity ratio (and therefore mobility ratio) of oil and water within the pattern, and the variation of vertical heterogeneity using Vdp. FIGURE 20 shows the result on incremental recovery at a water cut of 95%. As expected, favorable viscosity ratios or reduced Vdp, as can be achieved by the MCCF(4) process, yield increased incremental recoveries.

Figure 20
IDPM SENSITIVITY
TO VISCOSITY AND V_{DP}



WHAT WE'VE LEARNED

Improved sweep efficiency alone may be enough to make infill drilling economic in some reservoirs. This would expand the reservoirs that should be screened to include those that have relatively good continuity but poor sweep efficiency. Unocal has been successful in infill drilling in other West Texas reservoirs where the continuity was not the major deciding factor. These projects have greatly benefited from improved sweep efficiency.

When the IDPM was first run on North Riley, it inferred that there was more recoverable oil than previously thought. This led to detailed log analysis which better defined the reservoir and gave us a better estimation of the original oil in place. The increased oil in place estimate indicated that the waterflood was less efficient than previously believed. Consequently, the recovery estimates that were used for project justification were below those given by IDPM.

The first infill well potentialed for volumes similar to those seen when the field was first drilled. The average initial potential of the first 10 wells was double what was expected. This is a further indication, that the sweep efficiency prior to infill was lower than previously believed. Repeat formation testing of the infill wells indicated that the pressure distribution in the wellbore ranged from 2000 psi under hydrostatic to 50 psi over hydrostatic pressure. This vast difference was a further indicator of poor continuity between wells and of poor sweep efficiency that the flood was experiencing. Despite the poor continuity and sweep efficiency, the existing waterflood was economically very successful prior to infill.

CONCLUSIONS

1. IDPM appears to work when run with minimum data and applied to real field scale projects.
2. Layering and pattern type have major effects on IDPM results. The poorer the continuity between wells, the more the number of layers required to obtain valid simulations.
3. Low WF efficiency yields high infill.

ACKNOWLEDGMENTS

The authors thank Jeff Glossa, Eddie Howell, and Scott Gutberlet for their valuable contributions to this paper. We also wish to thank Unocal for permission to publish this paper. We thank Don Thurnau for additions and improvements to IDPM which made this paper possible. The IDPM was developed by SSI under a contract from the U.S. Department of Energy (BETC), DE-AC22-88BC14242.

We are grateful to Celeste Fan, Rosanne Turczynskyj, and Louise Hall for the final assembly of this paper.

NOMENCLATURE

A	=	Area, acres
Bo	=	Oil formation volume factor
C	=	Continuity (connectivity between wells), percent
Kro	=	Oil relative permeability, fraction
Kroe	=	End point (at Swc) oil relative permeability, fraction
Krw	=	Water relative permeability, fraction
Krwe	=	End point (at Sorw) water relative permeability, fraction
Ky/Kx	=	Anisotropy ratio, y-direction to x-direction permeability
OOIP	=	Original oil in place, Bbl
Soi	=	Initial oil saturation, fraction
Swc	=	Connate (irreducible) water saturation, fraction
Sorw	=	Residual oil saturation to water, fraction
Vdp	=	Dykstra-Parsons coefficient of permeability variation
Xno	=	Oil relative permeability curvature
Xnw	=	Water relative permeability curvature
ϕh	=	Porosity-net thickness product, feet

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APPENDIX 3b
IDPM BASE CASE INPUT/OUTPUT FOR IDPM SENSITIVITY ANALYSIS

S C I E N T I F I C   S O F T W A R E - I N T E R C O M P

INFILL DRILLING PREDICTION MODEL
(IDPM - RELEASE 1.2.0)

```
IDPM Sensitivity Analysis:  North Riley Unit Base Case
  IDPM Sensitivity Analysis:  North Riley Unit Base Case


0, 1, 1, 2, 0, 0.83
1, 11, 15, 1., 0.10, 0
40., 300., 933., .55, 200., 400., .75, 0.95, 0.
.000003, 3000., 2750., -6300., 107.
64.00, 0.0, .000003, .6 0.8
32.00, 1.28, .00000735, 1.7, 330.
2., 2., .752, .40, .32, .25, 0.
1
0.0800, 10., 400.
Economics for Waterflood
40, 53, 0, 2, 0, 1, 0, 0, 0, 0, 0, 0
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0.0, 0.001, 0.0
0.1, 0.05, 0.125, 0.08, 0.46, 0.1, 5.0, 0.04
0.0, 0.0, 0.0, 0.0, 23.07
0.0, 0.0, 0.0, 0.0, 0.0, 0.0
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16.00, 20.00, 24.00
2.67, 3.33, 4.00
33313., 41642., 49970.
.04, .05, .06
Economics for Infill Waterflood
40, 53, 0, 2, 0, 1, 0, 0, 0, 0, 0, 0
0.0, 0.0, 0.0, 0.03
0.0, 0.001, 0.0
0.1, 0.05, 0.125, 0.08, 0.46, 0.1, 5.0, 0.04
0.0, 0.0, 0.0, 0.0, 23.07
0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
6.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
16.00, 20.00, 24.00
2.67, 3.33, 4.00
33313., 41642., 49970.
.04, .05, .06
Economics for Infill over Non-Infill
40, 53, 0, 2, 0, 1, 0, 0, 0, 0, 0, 0
0.0, 0.0, 0.0, 0.03
0.0, 0.001, 0.0
0.1, 0.05, 0.125, 0.08, 0.46, 0.1, 5.0, 0.04
0.0, 0.0, 0.0, 0.0, 23.07
0.0, 0.0, 0.0, 0.0, 0.0, 0.0
6.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
16.00, 20.00, 24.00
2.67, 3.33, 4.00
```

33313., 41642., 49970.
.04, .05, .06
END

I D P M CURRENT MAXIMUM PARAMETER VALUES

NUMBER OF TUBES PER LAYER	16
NUMBER OF GRID CELLS PER TUBE	15
NUMBER OF LAYERS	20
NUMBER OF TIMESTEPS IN RESERVOIR RUN	5000
BLANK COMMON SIZE FOR RESERVOIR RUN	1000
NUMBER OF YEARS FOR ECONOMIC ANALYSIS.	50

SPECIFIED PRINTOUT CONTROLS

RESERVOIR ARRAY OUTPUT CONTROL	0	IARRP
RESERVOIR ANALYSIS OUTPUT CONTROL	1	IANALP
STREAMTUBE OUTPUT CONTROL	1	ISTRMP
ECONOMIC ANALYSIS CONTROL (0-NO, 1-YES)	2	IECONR

RESERVOIR PROPERTIES OUTPUT

FORMATION DEPTH -- SUBSURFACE	-6300.0	FEET
FORMATION TEMPERATURE	107.0	DEG F
INDIVIDUAL PATTERN AREA	40.0	ACRES
KV/KH VERTICAL TO HORIZONTAL PERM	0.100	
KY/KX ANISOTROPIC VALUE (1.0-100.0)	1.000	
DYKSTRA-PARSONS COEFFICIENT	0.83	VDP
PRESSURE AT FORMATION TOP	2750.0	PSIA
PORE VOLUME COMPRESSIBILITY	0.00000300	1/PSI
REFERENCE PRESSURE (POROSITY MEASURED)	3000.0	PSIA
NUMBER OF LAYERS	11	
STREAMTUBES PER LAYER	12	
NUMBER OF GRID CELLS PER STREAMTUBE	15	
INFILL PATTERN (0=5-SPOT, 1=0-SPOT)	0	

PROPERTIES BY LAYER

POROSITY	X-DIR PERM	NET PAY
0.0800	73.58	36.36
0.0800	15.09	36.36
0.0800	7.96	36.36
0.0800	4.86	36.36
0.0800	3.15	36.36
0.0800	2.09	36.36
0.0800	1.39	36.36
0.0800	0.91	36.36
0.0800	0.56	36.36
0.0800	0.30	36.36
0.0800	0.10	36.36

WATER DENSITY AT STANDARD CONDITIONS	64.00	LB/CUFT
WATER DENSITY AT RESERVOIR CONDITIONS	64.08	LB/CUFT
WATER FORMATION VOLUME FACTOR	1.00	VOL/VOL
WATER COMPRESSIBILITY AT RES. COND	0.00000300	1/PSI
WATER VISCOSITY AT RES. COND	0.60	CP

OIL DENSITY AT STANDARD CONDITIONS	54.00	LB/CUFT
OIL GRAVITY	32.00	DEG API

OIL DENSITY AT RESERVOIR CONDITIONS	42.19	LB/CUFT
OIL FORMATION VOLUME FACTOR	1.28	VOL/VOL
OIL COMPRESSIBILITY AT RES. COND	0.00000735	1/PSI
OIL VISCOSITY AT RES. COND	1.70	CP
SOLUTION GAS-OIL-RATIO	330.0	SCF/STB
GAS GRAVITY (AIR=1.0)	0.800	

INJECTION RATE (NON-INFILL)	200.0	STBW/D
INJECTION RATE (INFILL, BAY BE 0.0	400.0	STBW/D
WATER CUT AT INFILL (VCUT)	0.750	FRAC.
WATER CUT AT END (CUTMAX)	0.950	FRAC.
PLUG BACK AT INFILL (1=NO)	1	
(2=YES, IF LAYER W-CUT .GT. VCUT)		

RELATIVE PERMEABILITY DATA

IRREDUCIBLE WATER SATURATION	0.320	SWC
RESIDUAL OIL SATN -- INPUT --	0.250	SORW
OIL RELATIVE PERM END-POINT	0.752	XKROE
WATER RELATIVE PERM END-POINT	0.400	XKRWE
OIL RELATIVE PERM CURVATURE	2.00	XNO
WATER RELATIVE PERM CURVATURE	2.00	XNW
(MAX) WELL DIST. FOR CONN.=100%	300.000	VWD100
WELL DIST. FOR CONN.=VCONEC	933.000	VDBWLS
RESERVOIR CONNECTIVITY AT VDBWLS	0.500	VCONEC

RELATIVE PERMEABILITY TABLE
FOR CONNECTIVITY = 1.00000

WATER SATURATN	OIL KRO	WATER KRW	FW (FR FLOW)	D(FW) / D(SW)
0.3200	0.7520	0.0000	0.000	
0.3415	0.6787	0.0010	0.004	0.193
0.3630	0.6091	0.0040	0.018	0.656
0.3845	0.5433	0.0090	0.045	1.236
0.4060	0.4813	0.0160	0.086	1.919
0.4275	0.4230	0.0250	0.143	2.667
0.4490	0.3685	0.0360	0.217	3.412
0.4705	0.3177	0.0490	0.304	4.060
0.4920	0.2707	0.0640	0.401	4.514
0.5135	0.2275	0.0810	0.502	4.701
0.5350	0.1880	0.1000	0.601	4.601
0.5565	0.1523	0.1210	0.692	4.247
0.5780	0.1203	0.1440	0.772	3.713
0.5995	0.0921	0.1690	0.839	3.088
0.6210	0.0677	0.1960	0.891	2.452
0.6425	0.0470	0.2250	0.931	1.859
0.6640	0.0301	0.2560	0.960	1.342
0.6855	0.0169	0.2890	0.980	0.910
0.7070	0.0075	0.3240	0.992	0.564
0.7285	0.0019	0.3610	0.998	0.293
0.7500	0.0000	0.4000	1.000	0.085

FW = MOBW / (MOBW+MOBO), WHERE
MOBW = KRW/VISW, MOBO = KRO/VISO

PROPERTIES BY LAYER

POROSITY	X-DIR PERM	NET PAY	SO	SW
0.0800	73.58	36.36	0.6800	0.3200
0.0800	15.09	36.36	0.6800	0.3200

0.0800	7.96	36.36	0.6800	0.3200
0.0800	4.86	36.36	0.6800	0.3200
0.0800	3.15	36.36	0.6800	0.3200
0.0800	2.09	36.36	0.6800	0.3200
0.0800	1.39	36.36	0.6800	0.3200
0.0800	0.91	36.36	0.6800	0.3200
0.0800	0.56	36.36	0.6800	0.3200
0.0800	0.30	36.36	0.6800	0.3200
0.0800	0.10	36.36	0.6800	0.3200

N O N I N F I L L S I M U L A T I O N

SYMMETRY ELEMENT WITHIN 5-SPOT, BEFORE IN-FILL

ISOTROPIC PERMEABILITY CASE - 1/8

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I                                     I




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FRACTIONAL WELL RATES FOR TUBE CALCULATIONS
PRODUCER = 0.10000E+01
INJECTOR = -0.10000E+01

INJECTOR AT COORD (1, 65)
PRODUCER AT COORD (6 5, 1)

STREAM TUBES

1
19
35C
168C
149AC
1378BC
2457ABC
13679ABC
124689BCC
124578ABCC
1245689ABCC
12356789ABCC
12346789ABBCC
123456789ABCCC
1234567899ABCCC
1234567789AABCCC
12345567899ABBCCC
12344567889AABBCCC
113345677899AABCCCC
1133455678899ABBCCCC
1123455677889AABBCCCC

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11234456678899AABBCCCC
112344566778899AABBCCCC
112344556778899AABBBCCCC
1123345566778899AABBBCCCC
11233445667788999AABBBCCCC
11233445566778899AAABBBCCCC
112334455667788899AAABBBCCCC
112334455666778899AAABBBCCCC
1123334455667778899AAABBBCCCC
11223344556667788899AABBBBCCCC
11223344455667778899AAABBBBCCCC
11223334455666777889999AAABBBCCCCC
112233344555666778889999AAABBBCCCCC
1122233444556667778889999AAABBBBCCCC
11222333445556667778889999AAABBBBCCCC
112223334445556667778889999AAABBBBCCCC
1122233344455566677788889999AAABBBBCCCC
11222333344455566677788889999AAABBBBCCCC
111222333444555666677788889999AAABBBBCCCC
1112223334444555666777788889999AAAABBBCCCC
11122233334445555666777788889999AAAABBBCCCC
111222333344444555666677778888999AAAABBBCCCC
1112223333344445555666677778888999AAABBBCCCC
11112223333444445555666677778888999AAABBBCCCC
111122233333444455556666777778888999AAABBBCCCC
1111222233334444455556666677778888999AAABBBCCCC
11112222333334444455555666666777788889999AAABBCCCC
1111222223333344444555556666677778888999AAABBCCCC
111112222333333444444555556666677777888999AAABBCCCC
1111122222333333444444555555666667777888999AABBBCCC
11111222223333333444444555556666677777888999AAABBCCC
111111222223333333444444455555666666777777888999AABBCCC
111111222222333333333444444455555666666777777888999AABBCCC
11111111222222233333333334444444455555566666677777888999AABBCC
1111111112222222333333333344444444555555666666777888999ABBCC
1111111112222222233333333334444444455555566666677777888899AABCC
111111111112222222222333333333333444444445555556667777778899ABCC
11111111111122222222222333333333333444444444555556667777889AABC
1111111111111122222222222223333333333334444444445555566677889ABC
1111111111111111122222222222222233333333333344444444455566778 9AAC
111111111111111111122222222222222223333333333333344444455556788BB
111111111111111111111111112222222222222222222233333333344456779C
1111111111111111111111111111111111111111111111111122222222222234343568
11111111111111111111111111111111111111111111111112211111111112121212
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RELATIVE PERMEABILITY TABLE
FOR CONNECTIVITY = 0.55000

WATER SATURATN	OIL KRO	WATER KRW	FW (FR FLOW)	D(FW) / D(SW)
0.3200	0.7520	0.0000	0.000	
0.3415	0.6215	0.0033	0.015	0.691
0.3630	0.5034	0.0132	0.069	2.531
0.3845	0.3978	0.0298	0.175	4.912
0.4060	0.3045	0.0529	0.330	7.206
0.4275	0.2237	0.0826	0.511	8.445
0.4490	0.1554	0.1190	0.685	8.055
0.4705	0.0994	0.1620	0.822	6.389
0.4920	0.0559	0.2116	0.915	4.313
0.5135	0.0249	0.2678	0.968	2.494
0.5350	0.0062	0.3306	0.993	1.169
0.5565	0.0000	0.4000	1.000	0.307
0.5780	0.0000	0.4760	1.000	0.000
0.5995	0.0000	0.5587	1.000	0.000
0.6210	0.0000	0.6479	1.000	0.000
0.6425	0.0000	0.7438	1.000	0.000
0.6640	0.0000	0.8463	1.000	0.000
0.6855	0.0000	0.9554	1.000	0.000

0.7070	0.0000	1.0000	1.000	0.000
0.7285	0.0000	1.0000	1.000	0.000
0.7500	0.0000	1.0000	1.000	0.000

SIMULATED FLOODING OF SYMMETRY ELEMENT STREAM TUBES

(ALL VOLUMES/RATES GIVEN BELOW ARE FOR THE SYMMETRY ELEMENT WHICH HAS 1.0/8.0 OF THE AREA OF THE PRE-INFILL 5-SPOT.)

		---- IN - PLACE - VOLUMES ---		
LAYER	TUBE	OIL (SCF)	WATER (SCF)	PORE VOL. (RCF)
1	1	0.46723E+05	0.28211E+05	0.88107E+05
2	1	0.46728E+05	0.28212E+05	0.88110E+05
3	1	0.46733E+05	0.28214E+05	0.88113E+05
4	1	0.46738E+05	0.28216E+05	0.88116E+05
5	1	0.46743E+05	0.28218E+05	0.88118E+05
6	1	0.46749E+05	0.28220E+05	0.88121E+05
7	1	0.46754E+05	0.28221E+05	0.88124E+05
8	1	0.46759E+05	0.28223E+05	0.88127E+05
9	1	0.46764E+05	0.28225E+05	0.88130E+05
10	1	0.46769E+05	0.28227E+05	0.88133E+05
11	1	0.46774E+05	0.28229E+05	0.88135E+05
1	2	0.35616E+05	0.21504E+05	0.67162E+05
2	2	0.35620E+05	0.21506E+05	0.67165E+05
3	2	0.35624E+05	0.21507E+05	0.67167E+05
4	2	0.35628E+05	0.21508E+05	0.67169E+05
5	2	0.35632E+05	0.21510E+05	0.67171E+05
6	2	0.35636E+05	0.21511E+05	0.67173E+05
7	2	0.35639E+05	0.21513E+05	0.67175E+05
8	2	0.35643E+05	0.21514E+05	0.67177E+05
9	2	0.35647E+05	0.21515E+05	0.67180E+05
10	2	0.35651E+05	0.21517E+05	0.67182E+05
11	2	0.35655E+05	0.21518E+05	0.67184E+05
1	3	0.37296E+05	0.22519E+05	0.70331E+05
2	3	0.37300E+05	0.22520E+05	0.70333E+05
3	3	0.37304E+05	0.22522E+05	0.70336E+05
4	3	0.37309E+05	0.22523E+05	0.70338E+05
5	3	0.37313E+05	0.22525E+05	0.70340E+05
6	3	0.37317E+05	0.22526E+05	0.70342E+05
7	3	0.37321E+05	0.22528E+05	0.70345E+05
8	3	0.37325E+05	0.22529E+05	0.70347E+05
9	3	0.37329E+05	0.22530E+05	0.70349E+05
10	3	0.37333E+05	0.22532E+05	0.70351E+05
11	3	0.37337E+05	0.22533E+05	0.70354E+05
1	4	0.30657E+05	0.18510E+05	0.57811E+05
2	4	0.30660E+05	0.18511E+05	0.57813E+05
3	4	0.30663E+05	0.18512E+05	0.57814E+05
4	4	0.30667E+05	0.18514E+05	0.57816E+05
5	4	0.30670E+05	0.18515E+05	0.57818E+05
6	4	0.30674E+05	0.18516E+05	0.57820E+05
7	4	0.30677E+05	0.18517E+05	0.57822E+05
8	4	0.30680E+05	0.18518E+05	0.57824E+05
9	4	0.30684E+05	0.18520E+05	0.57825E+05
10	4	0.30687E+05	0.18521E+05	0.57827E+05
11	4	0.30691E+05	0.18522E+05	0.57829E+05
1	5	0.25902E+05	0.15640E+05	0.48845E+05
2	5	0.25905E+05	0.15641E+05	0.48847E+05
3	5	0.25908E+05	0.15642E+05	0.48848E+05
4	5	0.25911E+05	0.15643E+05	0.48850E+05
5	5	0.25914E+05	0.15644E+05	0.48852E+05
6	5	0.25917E+05	0.15645E+05	0.48853E+05
7	5	0.25920E+05	0.15646E+05	0.48855E+05
8	5	0.25922E+05	0.15647E+05	0.48856E+05
9	5	0.25925E+05	0.15648E+05	0.48858E+05
10	5	0.25928E+05	0.15649E+05	0.48859E+05

11	5	0.25931E+05	0.15650E+05	0.48861E+05
1	6	0.24919E+05	0.15046E+05	0.46990E+05
2	6	0.24922E+05	0.15047E+05	0.46992E+05
3	6	0.24924E+05	0.15048E+05	0.46993E+05
4	6	0.24927E+05	0.15048E+05	0.46995E+05
5	6	0.24930E+05	0.15049E+05	0.46997E+05
6	6	0.24933E+05	0.15050E+05	0.46998E+05
7	6	0.24935E+05	0.15051E+05	0.47000E+05
8	6	0.24938E+05	0.15052E+05	0.47001E+05
9	6	0.24941E+05	0.15053E+05	0.47003E+05
10	6	0.24944E+05	0.15054E+05	0.47014E+05
11	6	0.24946E+05	0.15055E+05	0.47006E+05
1	7	0.24263E+05	0.14650E+05	0.45754E+05
2	7	0.24266E+05	0.14651E+05	0.45755E+05
3	7	0.24268E+05	0.14652E+05	0.45757E+05
4	7	0.24271E+05	0.14652E+05	0.45758E+05
5	7	0.24274E+05	0.14653E+05	0.45760E+05
6	7	0.24276E+05	0.14654E+05	0.45761E+05
7	7	0.24279E+05	0.14655E+05	0.45763E+05
8	7	0.24282E+05	0.14656E+05	0.45764E+05
9	7	0.24284E+05	0.14657E+05	0.45766E+05
10	7	0.24287E+05	0.14658E+05	0.45767E+05
11	7	0.24290E+05	0.14659E+05	0.45769E+05
1	8	0.22870E+05	0.13808E+05	0.43126E+05
2	8	0.22872E+05	0.13809E+05	0.43128E+05
3	8	0.22875E+05	0.13810E+05	0.43129E+05
4	8	0.22877E+05	0.13811E+05	0.43130E+05
5	8	0.22880E+05	0.13812E+05	0.43132E+05
6	8	0.22882E+05	0.13813E+05	0.43133E+05
7	8	0.22885E+05	0.13814E+05	0.43134E+05
8	8	0.22887E+05	0.13814E+05	0.43136E+05
9	8	0.22890E+05	0.13815E+05	0.43137E+05
10	8	0.22892E+05	0.13816E+05	0.43139E+05
11	8	0.22895E+05	0.13817E+05	0.43140E+05
1	9	0.20738E+05	0.12522E+05	0.39107E+05
2	9	0.20741E+05	0.12522E+05	0.39108E+05
3	9	0.20743E+05	0.12523E+05	0.39110E+05
4	9	0.20745E+05	0.12524E+05	0.39111E+05
5	9	0.20748E+05	0.12525E+05	0.39112E+05
6	9	0.20750E+05	0.12526E+05	0.39113E+05
7	9	0.20752E+05	0.12526E+05	0.39115E+05
8	9	0.20754E+05	0.12527E+05	0.39116E+05
9	9	0.20757E+05	0.12528E+05	0.39117E+05
10	9	0.20759E+05	0.12529E+05	0.39118E+05
11	9	0.20761E+05	0.12530E+05	0.39120E+05
1	10	0.20165E+05	0.12175E+05	0.38025E+05
2	10	0.20167E+05	0.12176E+05	0.38026E+05
3	10	0.20169E+05	0.12177E+05	0.38028E+05
4	10	0.20171E+05	0.12177E+05	0.38029E+05
5	10	0.20173E+05	0.12178E+05	0.38030E+05
6	10	0.20176E+05	0.12179E+05	0.38031E+05
7	10	0.20178E+05	0.12180E+05	0.38032E+05
8	10	0.20180E+05	0.12181E+05	0.38034E+05
9	10	0.20182E+05	0.12181E+05	0.38035E+05
10	10	0.20185E+05	0.12182E+05	0.38036E+05
11	10	0.20187E+05	0.12183E+05	0.38037E+05
1	11	0.21230E+05	0.12818E+05	0.40035E+05
2	11	0.21233E+05	0.12819E+05	0.40036E+05
3	11	0.21235E+05	0.12820E+05	0.40037E+05
4	11	0.21237E+05	0.12821E+05	0.40038E+05
5	11	0.21240E+05	0.12822E+05	0.40040E+05
6	11	0.21242E+05	0.12823E+05	0.40041E+05
7	11	0.21244E+05	0.12823E+05	0.40042E+05
8	11	0.21247E+05	0.12824E+05	0.40044E+05
9	11	0.21249E+05	0.12825E+05	0.40045E+05
10	11	0.21251E+05	0.12826E+05	0.40046E+05
11	12	0.21254E+05	0.12827E+05	0.40047E+05

1	12	0.25411E+05	0.15343E+05	0.47918E+05
2	12	0.25413E+05	0.15344E+05	0.47919E+05
3	12	0.25416E+05	0.15345E+05	0.47921E+05
4	12	0.25419E+05	0.15346E+05	0.47923E+05
5	12	0.25422E+05	0.15346E+05	0.47924E+05
6	12	0.25425E+05	0.15347E+05	0.47926E+05
7	12	0.25427E+05	0.15348E+05	0.47927E+05
8	12	0.25430E+05	0.15349E+05	0.47929E+05
9	12	0.25433E+05	0.15350E+05	0.47930E+05
10	12	0.25436E+05	0.15351E+05	0.47932E+05
11	12	0.25439E+05	0.15352E+05	0.47933E+05
TOTALS		0.36957E+07	0.22309E+07	0.69665E+07
(M-STB)		658.19	397.31	

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
0.2	65.9	65.901	1	1

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
21.01	0.4062E-10	25.00	1384.	0.2677E-08	1648.

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
656.81	398.96	2869.8

MATERIAL BALANCE ERROR	
OIL	WATER
1.0000	1.0000

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
0.4	131.8	65.901	2	2

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
19.68	0.2425E-04	25.00	2681.	0.1598E-02	3296.

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
655.51	400.61	2870.4

MATERIAL BALANCE ERROR	
OIL	WATER
1.0000	1.0000

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
13.7	5008.5	65.901	76	76

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
7.024	16.00	25.00	0.6512E+05	0.4185E+05	0.1252E+06

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
592.94	480.95	2885.6

```
    MATERIAL BALANCE ERROR
OIL                WATER
0.99980            1.0007
```

PERIODIC REPORT ON STATUS OF SIMULATION

```
           YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
           17.5       6392.4    65.901        97                97

PRODUCTION/INJECTION RATE (STB/D)        CUMULATIVE PRODU CTION/INJECTION (STB)
     OIL        WATER      INJECTION           OIL        WATER       INJECTION
    5.795   17.59           25.00          0.7389E+05  0.6523E+05     0.1598E+06

     CURRENT IN-PLACE-VOLUMES                             MAXIMUM
OIL (MSTB)          WATER (MSTB)                         PRESSURE
  584.13              492.25                                2887.8

    MATERIAL BALANCE ERROR
OIL                WATER
0.99973            1.0009
```

CONTINUATION OF WATERFLOOD AFTER WATER CUT FOR INFILL

PERIODIC REPORT ON STATUS OF SIMULATION

```
           YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
           17.7       6458.3    65.901        1                 98

PRODUCTION/INJECTION RATE (STB/D)        CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL        WATER      INJECTION           OIL        WATER       INJECTION
    5.769   17.62           25.00          0.7427E+05  0.6639E+05     0.1615E+06

     CURRENT IN-PLACE-VOLUMES                             MAXIMUM
OIL (MSTB)          WATER (MSTB)                         PRESSURE
  583.75              492.75                                2887.9

    MATERIAL BALANCE ERROR
OIL                WATER
0.99973            1.0009
```

PERIODIC REPORT ON STATUS OF SIMULATION

```
           YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
           27.2       9951.1    65.901        54                151

PRODUCTION/INJECTION RATE (STB/D)        CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL        WATER      INJECTION           OIL        WATER       INJECTION
    4.123   19.70           25.00          .09114E+05  0.1321E+06     0.2488E+06

     CURRENT IN-P LACE-VOLUMES                            MAXIMUM
OIL (MSTB)          WATER (MSTB)                         PRESSURE
  566.82              514.49                                2893.0

    MATERIAL BALANCE ERROR
OIL                WATER
0.99962            1.0012
```

```
                  PERIODIC REPORT ON STATUS OF SIMULATION

          YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
          40.8       14893.7   65.901         129               226

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL       WATER      INJECTION          OIL        WATER       INJECTION
    2.924   21.25           25.00         0.1083E+06  0.2338E+06     0.3724E+06

     CURRENT IN-PLACE-VOLUMES                            MAXIMUM
OIL (MSTB)        WATER (MSTB)                          PRESSURE
  549.65            536.52                                 2898.5

     MATERIAL BALANCE ERROR
OIL               WATER
0.99957           1.0015
```

```
                  PERIODIC REPORT ON STATUS OF SIMULATION

          YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
          54.5       19902.1   65.901         205               302

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL       WATER      INJECTION          OIL        WATER       INJECTION
    2.238   22.13           25.00         0.1211E+06  0.3426E+06     0.4976E+06

     CURRENT IN-PLACE-VOLUMES                            MAXIMUM
OIL (MSTB)        WATER (MSTB)                          PRESSURE
  536.82            552.99                                 2902.2

     MATERIAL BALANCE ERROR
OIL               WATER
0.99954           1.0016
```

```
                  PERIODIC REPORT ON STATUS OF SIMULATION

          YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
          68.0       24844.7   65.901         280               377

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL       WATER      INJECTION          OIL        WATER       INJECTION
    1.805   22.73           25.00         0.1309E+06  0.4536E+06     0.6212E+06

     CURRENT IN-PLACE-VOLUMES                            MAXIMUM
OIL (MSTB)        WATER (MSTB)                          PRESSURE
  526.97            565.62                                 2904.5

     MATERIAL BALANCE ERROR
OIL               WATER
0.99955           1.0018
```

```
                  PERIODIC REPORT ON STATUS OF SIMULATION

          YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
          81.6       29787.2   65.901         355               452

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL       WATER      INJECTION          OIL        WATER       INJECTION
    1.479   23.12           25.00         0.1389E+06  0.5671E+06     0.7448E+06

     CURRENT IN-PLACE-VOLUMES                            MAXIMUM
OIL (MSTB)        WATER (MSTB)                          PRESSURE
  519.03            575.81                                 2906.1
```

MATERIAL BALANCE ERROR

OIL	WATER
0.99961	1.0019

****

TIME STEPS EXECUTED 524
GRID-CELL-TIME-STEPS 11412720

I N F I L L S I M U L A T I O

SYMMETRY ELEMENT AFTER 5-SPOT IN-FILL

ISOTROPIC PERMEABILITY CASE - 1/8

```
I          P          I



P          I          P



I          P          I
```

FRACTIONAL WELL RATES FOR TUBE CALCULATIONS

```
     PRODUCER    =   0.10000E+01
 Y-DIR INJECTOR  =  -0.50000E+00
 X-DIR INJECTOR  =  -0.50000E+00

INJECTOR AT COORD (  1, 65 )
INJECTOR AT COORD ( 65,  1 )
PRODUCER AT COORD (  1,  1 )
```

STREAMTUBES

```
1
35
146
1356
12466
134566
1234566
12345666
123445666
1233455666
12234456666
122344556666
1223345556666
12233445556666
112334445566666
1122334455566666
11223344455566666
112233344555566666
1122333444555666666
```

11222334445555666666
112223334445556666666
1122233344455556666666
11222333444455556666666
111222333444555566666666
1112223334445555566666666
11122233344445555566666666
111222333444455555666666666
1112223334444555556666666666
11122233344445555566666666666
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1112223334444455555666666667777777
11122233344444555556666666777777777
111222333444455555666666667777777777
1112223334444555556666666677777777777
11122233344445555566666667777777777777
111222333444455555666666777777777777777
1112223334444555566666677777777777777777
11122233344455555666666777777777777777777
111223333444555556666677777777777777777777
1122233344445556666667777777888888888877777
11222333444455566666777777788888888888877777
112223334445555666677777788888888888888877777
1122233444455566667777778888888888888888877777
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1122334445556666777888888999999999999999888888777
11233344555666677788888899999999999999999888888777
112334445566667778888899999999999999999999988888777
1123344556666778888899999999999999999999999998888777
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1223445667778889999999AAAAAAAAAAAAAAAAA99999999988877
1233455677788899999AAAAAAAAAAAAAAAAAAAAAAA9999988877
12344566778899999AAAAAAAAAAAAAAAAAAAAAAAAAA999998877
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1234567889999AAAAAABBBBBBBBBBBBBBBBBBBBBAAAAAA9998887
12456788999AAAAABBBBBBBBBBBBBBBBBBBBBBBBBAAAAAA999887
13567899AAAAABBBBBBBBBBBBBBBBBBBBBBBBBBBBBBAAAAA99887
1467899AAABBBBBBBCCCCCCCCCCCCCCCCCCCCCBBBBBBBAAA9987
23689AABBBBBBBBBCCCCCCCCCCCCCCCCCCCCCCCCBBBBBBBAA988
159BBBBCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCBBAA7
1ABCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCA7

RELATIVE PERMEABILITY TABLE
FOR CONNECTIVITY = 0.71195

WATER SATURATN	OIL KRO	WATER KRW	FW (FR FLOW)	D(FW) / D(SW)
0.3200	0.7520	0.0000	0.000	
0.3415	0.6501	0.0020	0.009	0.397
0.3630	0.5556	0.0079	0.039	1.403
0.3845	0.4685	0.0178	0.097	2.711
0.4060	0.6888	0.0316	0.187	4.187
0.4275	0.3166	0.0493	0.306	5.546
0.4490	0.2518	0.0710	0.444	6.418
0.4705	0.1944	0.0967	0.585	6.545
0.4920	0.1444	0.1263	0.712	5.932
0.5135	0.1018	0.1598	0.816	4.835
0.5350	0.0666	0.1973	0.893	3.583
0.5565	0.0389	0.2387	0.946	2.425
0.5780	0.0186	0.2841	0.977	1.480
0.5995	0.0057	0.3334	0.994	0.771
0.6210	0.0002	0.3867	1.000	0.270
0.6425	0.0000	0.4439	1.000	0.009
0.6640	0.0000	0.5051	1.000	0.000
0.6855	0.0000	0.5702	1.000	0.000
0.7070	0.0000	0.6392	1.000	0.000
0.7285	0.0000	0.7122	1.000	0.000
0.7500	0.0000	0.7892	1.000	0.000

FW == MOBW / (MOBW+MOBO), WHERE
MOBW = KRW/VISW, MOBO = KRO/VISO

SIMULATED FLOODING OF SYMMETRY ELEMENT STREAM TUBES

(ALL VOLUMES/RATES GIVEN BELOW ARE FOR THE SYMMETRY ELEMENT WHICH HAS 1.0/8.0 OF THE AREA OF THE PRE-INFILL 5-SPOT.)

		---- IN - PLACE - VOLUMES ---		
LAYER	TUBE	OIL (SCF)	WATER (SCF)	PORE VOL. (RCF)
1	1	0.97984E+04	0.14339E+05	0.26896E+05
2	1	0.99496E+04	0.14148E+05	0.26897E+05
3	1	0.10323E+05	0.13673E+05	0.26898E+05
4	1	0.10689E+05	0.13207E+05	0.26899E+05
5	1	0.11209E+05	0.12542E+05	0.26900E+05
6	1	0.11945E+05	0.11601E+05	0.26901E+05
7	1	0.12738E+05	0.10585E+05	0.26902E+05
8	1	0.13364E+05	0.97858E+04	0.26903E+05
9	1	0.13764E+05	0.92747E+04	0.26904E+05
10	1	0.14017E+05	0.89530E+04	0.26904E+05
11	1	0.14194E+05	0.87281E+04	0.26905E+05
1	2	0.13840E+05	0.20133E+05	0.37870E+05
2	2	0.14052E+05	0.19865E+05	0.37871E+05
3	2	0.14603E+05	0.19163E+05	0.37873E+05
4	2	0.15141E+05	0.18477E+05	0.37875E+05
5	2	0.15932E+05	0.17467E+05	0.37876E+05
6	2	0.17126E+05	0.15939E+05	0.37878E+05
7	2	0.18240E+05	0.14513E+05	0.37879E+05
8	2	0.18959E+05	0.13594E+05	0.37880E+05
9	2	0.19432E+05	0.12991E+05	0.37881E+05
10	2	0.19756E+05	0.12578E+05	0.37882E+05
11	2	0.19990E+05	0.12282E+05	0.37883E+05
1	3	0.15012E+05	0.21721E+05	0.40961E+05
2	3	0.15229E+05	0.21448E+05	0.40963E+05
3	3	0.15840E+05	0.20669E+05	0.40965E+05
4	3	0.16445E+05	0.19899E+05	0.40967E+05

5	3	0.17398E+05	0.18679E+05	0.40968E+05
6	3	0.18835E+05	0.16840E+05	0.40969E+05
7	3	0.19868E+05	0.15519E+05	0.40971E+05
8	3	0.20591E+05	0.14595E+05	0.40972E+05
9	3	0.21090E+05	0.13958E+05	0.40973E+05
10	3	0.21415E+05	0.13545E+05	0.40974E+05
11	3	0.21638E+05	0.13263E+05	0.40975E+05
1	4	0.18141E+05	0.26212E+05	0.49462E+05
2	4	0.18409E+05	0.25875E+05	0.49464E+05
3	4	0.19155E+05	0.24924E+05	0.49467E+05
4	4	0.19895E+05	0.23980E+05	0.49469E+05
5	4	0.21109E+05	0.22429E+05	0.49471E+05
6	4	0.22831E+05	0.20223E+05	0.49472E+05
7	4	0.24198E+05	0.18475E+05	0.49474E+05
8	4	0.25062E+05	0.17371E+05	0.49475E+05
9	4	0.25564E+05	0.16731E+05	0.49477E+05
10	4	0.25894E+05	0.16312E+05	0.49478E+05
11	4	0.26138E+05	0.16004E+05	0.49480E+05
1	5	0.20622E+05	0.29679E+05	0.56109E+05
2	5	0.20916E+05	0.29308E+05	0.56111E+05
3	5	0.21778E+05	0.28210E+05	0.56114E+05
4	5	0.22644E+05	0.27105E+05	0.56116E+05
5	5	0.24127E+05	0.25208E+05	0.56118E+05
6	5	0.26149E+05	0.22620E+05	0.56120E+05
7	5	0.27691E+05	0.20648E+05	0.56122E+05
8	5	0.28575E+05	0.19518E+05	0.56123E+05
9	5	0.29102E+05	0.18847E+05	0.56125E+05
10	5	0.29438E+05	0.18421E+05	0.56127E+05
11	5	0.29673E+05	0.18124E+05	0.56128E+05
1	6	0.33202E+05	0.47405E+05	0.89959E+05
2	6	0.33649E+05	0.46843E+05	0.89963E+05
3	6	0.35082E+05	0.45015E+05	0.89967E+05
4	6	0.36536E+05	0.43161E+05	0.89971E+05
5	6	0.39079E+05	0.39907E+05	0.89974E+05
6	6	0.42905E+05	0.35008E+05	0.89977E+05
7	6	0.45255E+05	0.32001E+05	0.89980E+05
8	6	0.46331E+05	0.30629E+05	0.89982E+05
9	6	0.46936E+05	0.29860E+05	0.89985E+05
10	6	0.47328E+05	0.29366E+05	0.89988E+05
11	6	0.47615E+05	0.29006E+05	0.89990E+05
1	7	0.28310E+05	0.37210E+05	0.73496E+05
2	7	0.28198E+05	0.37362E+05	0.73500E+05
3	7	0.29754E+05	0.35374E+05	0.73503E+05
4	7	0.31694E+05	0.32894E+05	0.73506E+05
5	7	0.36091E+05	0.27261E+05	0.73508E+05
6	7	0.38975E+05	0.23567E+05	0.73510E+05
7	7	0.39086E+05	0.23431E+05	0.73513E+05
8	7	0.39057E+05	0.23474E+05	0.73515E+05
9	7	0.39035E+05	0.23510E+05	0.73517E+05
10	7	0.39029E+05	0.23524E+05	0.73519E+05
11	7	0.39021E+05	0.23540E+05	0.73521E+05
1	8	0.23389E+05	0.30146E+05	0.60126E+05
2	8	0.23182E+05	0.30419E+05	0.60129E+05
3	8	0.24539E+05	0.28685E+05	0.60131E+05
4	8	0.26356E+05	0.26361E+05	0.60134E+05
5	8	0.30579E+05	0.20948E+05	0.60136E+05
6	8	0.31999E+05	0.19133E+05	0.60137E+05
7	8	0.31982E+05	0.19160E+05	0.60139E+05
8	8	0.31957E+05	0.19197E+05	0.60141E+05
9	8	0.31938E+05	0.19227E+05	0.60143E+05
10	8	0.31933E+05	0.19238E+05	0.60145E+05
11	8	0.31922E+05	0.19258E+05	0.60147E+05
1	9	0.22654E+05	0.28460E+05	0.57498E+05
2	9	0.22295E+05	0.28927E+05	0.57501E+05
3	9	0.23672E+05	0.27168E+05	0.57503E+05
4	9	0.25717E+05	0.24550E+05	0.57506E+05
5	9	0.29726E+05	0.19413E+05	0.57507E+05

6	9	0.30621E+05	0.18269E+05	0.57509E+05
7	9	0.30590E+05	0.18314E+05	0.57511E+05
8	9	0.30565E+05	0.18352E+05	0.57513E+05
9	9	0.30546E+05	0.18381E+05	0.57514E+05
10	9	0.30542E+05	0.18391E+05	0.57516E+05
11	9	0.30532E+05	0.18410E+05	0.57518E+05
1	10	0.19681E+05	0.23924E+05	0.49152E+05
2	10	0.19186E+05	0.24565E+05	0.49154E+05
3	10	0.20417E+05	0.22991E+05	0.49156E+05
4	10	0.22495E+05	0.20330E+05	0.49158E+05
5	10	0.25655E+05	0.16281E+05	0.49159E+05
6	10	0.26151E+05	0.15649E+05	0.49161E+05
7	10	0.26131E+05	0.15679E+05	0.49162E+05
8	10	0.26110E+05	0.15711E+05	0.49164E+05
9	10	0.26095E+05	0.15734E+05	0.49165E+05
10	10	0.26094E+05	0.15740E+05	0.49167E+05
11	10	0.26081E+05	0.15761E+05	0.49168E+05
1	11	0.19145E+05	0.22292E+05	0.46833E+05
2	11	0.18449E+05	0.23190E+05	0.46835E+05
3	11	0.19667E+05	0.21633E+05	0.46837E+05
4	11	0.22016E+05	0.18624E+05	0.46839E+05
5	11	0.24644E+05	0.15257E+05	0.46840E+05
6	11	0.24903E+05	0.14929E+05	0.46842E+05
7	11	0.24882E+05	0.14961E+05	0.46843E+05
8	11	0.24871E+05	0.14978E+05	0.46845E+05
9	11	0.24867E+05	0.14987E+05	0.46846E+05
10	11	0.24862E+05	0.14998E+05	0.46848E+05
11	11	0.24854E+05	0.15013E+05	0.46849E+05
1	12	0.18694E+05	0.20860E+05	0.44824E+05
2	12	0.17877E+05	0.21914E+05	0.44826E+05
3	12	0.19113E+05	0.20334E+05	0.44828E+05
4	12	0.21728E+05	0.16983E+05	0.44829E+05
5	12	0.23697E+05	0.14460E+05	0.44831E+05
6	12	0.23813E+05	0.14317E+05	0.44832E+05
7	12	0.23802E+05	0.14334E+05	0.44834E+05
8	12	0.23796E+05	0.14346E+05	0.44835E+05
9	12	0.23794E+05	0.14353E+05	0.44836E+05
10	12	0.23787E+05	0.14366E+05	0.44838E+05
11	12	0.23778E+05	0.14381E+05	0.44839E+05
TOTALS		0.32801E+07	0.27638E+07	0.69663E+07
(M-STB)		584.16	492.22	

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
17.6	6425.4	32.951	1	98

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
15.66	30.40	50.01	515.9	1002.	1648.

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
583.60	492.94	2901.1

MATERIAL BALANCE ERROR	
OIL	WATER
0.99991	1.0001

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS

17.1	6458.3	32.951	2	99

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
15.36	30.40	50.01	1022.	2003.	3296.

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
583.09	493.58	2904.1

MATERIAL BALANCE ERROR	
OIL	WATER
0.99991	1.0001

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
24.4	8896.7	32.951	76	173

PRODUCTION/INJECTION RATE (STB/D)			CUMULATIVE PRODUCTION/INJECTION (STB)		
OIL	WATER	INJECTION	OIL	WATER	INJECTION
8.443	39.19	50.01	0.2866E+05	0.8854E+05	0.1252E+06

CURRENT IN-PLACE-VOLUMES		MAXIMUM
OIL (MSTB)	WATER (MSTB)	PRESSURE
555.36	529.15	2911.3

MATERIAL BALANCE ERROR	
OIL	WATER
0.99975	1.0005

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
31.1	11367.9	32.951	151	248

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PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL       WATER      INJECTION          OIL       WATER       INJECTION
    6.299   41.93           50.01        0.4648E+05  0.1893E+06     0.2488E+06

     CURRENT IN-PLACE-VOLUMES                             MAXIMUM
OIL (MSTB)        WATER (MSTB)                           PRESSURE
  537.47             552.11                                2915.6

     MATERIAL BALANCE ERROR
OIL                WATER
0.99962            1.0007
```

PERIODIC REPORT ON STATUS OF SIMULATION

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           YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
           37.9       13839.2   32.951         226                323

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL       WATER      INJECTION          OIL       WATER       INJECTION
    5.139      43.42        50.01       0.65050E+05  0.2949E+06    0.3724E+06

     CURRENT IN-PLACE-VOLUMES                             MAXIMUM
OIL (MSTB)        WATER (MSTB)                           PRESSURE
  523.41             570.14                                2917.1

     MATERIAL BALANCE ERROR
OIL                WATER
0.99955            1.0009
```

PERIODIC REPORT ON STATUS OF SIMULATION

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           YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
           44.7       16343.4   32.951         302                399

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTION/INJECTION (STB)
     OIL       WATER      INJECTION          OIL       WATER       INJECTION
    4.308   44.48           50.01        0.7229E+05  0.4050E+06     0.4976E+06

     CURRENT IN-PLACE-VOLUMES                             MAXIMUM
OIL (MSTB)        WATER (MSTB)                           PRESSURE
  511.60             585.30                                2917.9

     MATERIAL BALANCE ERROR
OIL                WATER
0.99951            1.0010
```

PERIODIC REPORT ON STATUS OF SIMULATION

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           YEARS      DAYS      DELTA-T     CASE STEPS       TOTAL STEPS
           51.5       18814.7   32.951         377                474

PRODUCTION/INJECTION RATE (STB/D)       CUMULATIVE PRODUCTI ON/INJECTION (STB)
     OIL       WATER      INJECTION          OIL       WATER       INJECTION
    3.704   45.29           50.01       0.8218E+05   0.5160E+06     0.6212E+06

     CURRENT IN-PLACE-VOLUMES                             MAXIMUM
OIL (MSTB)        WATER (MSTB)                           PRESSURE
  501.70             598.00                                2918.5

     MATERIAL BALANCE ERROR
OIL                WATER
0.99949            1.0011
```

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
58.3	21286.1	32.951	452	549

PRODUCTION/INJECTION RATE (STB/D) CUMULATIVE PRODUCTION/INJECTION (STB)

OIL	WATER	INJECTION	OIL	WATER	INJECTION
3.220	45.90	50.01	0.9070E+05	0.6287E+06	0.7448E+06

CURRENT IN-PLACE-VOLUMES MAXIMUM

OIL (MSTB)	WATER (MSTB)	PRESSURE
493.19	608.92	2918.4

MATERIAL BALANCE ERROR

OIL	WATER
0.99950	1.0011

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
65.1	23790.4	32.951	528	625

PRODUCTION/INJECTION RATE (STB/D) CUMULATIVE PRODUCTION/INJECTION (STB)

OIL	WATER	INJECTION	OIL	WATER	INJECTION
2.844	46.39	50.01	0.9825E+05	0.7443E+06	0.8701E+06

CURRENT IN-PLACE-VOLUMES MAXIMUM

OIL (MSTB)	WATER (MSTB)	PRESSURE
485.65	618.59	2918.3

MATERIAL BALANCE ERROR

OIL	WATER
0.99951	1.0012

PERIODIC REPORT ON STATUS OF SIMULATION

YEARS	DAYS	DELTA-T	CASE STEPS	TOTAL STEPS
71.9	26261.7	32.951	603	700

PRODUCTION/INJECTION RATE (STB/D) CUMULATIVE PRODUCTION/INJECTION (STB)

OIL	WATER	INJECTION	OIL	WATER	INJECTION
2.487	46.84	50.01	0.1048E+06	0.8595E+06	0.9937E+06

CURRENT IN-PLACE-VOLUMES MAXIMUM

OIL (MSTB)	WATER (MSTB)	PRESSURE
479.11	626.98	2918.3

MATERIAL BALANCE ERROR

OIL	WATER
0.99953	1.0013

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TIME STEPS EXECUTED 609
GRID-CELL-TIME-STEPS 13264020

PERFORMANCE VERSUS TIME FOR NON-INFILL

TIME DAYS	OIL RATE STB/D	WATER RATE STB/D	CUMOIL MSTB	WCUT FRAC.	PV INJ FRAC.	OIL REC % OOIP
65.90	21.01	0.4062E-10	1.384	0.000	0.00	0.2
131.80	19.68	0.2425E-04	2.681	0.000	0.00	0.4
197.70	19.58	0.1479E-03	3.971	0.000	0.00	0.6

263.60	19.53	0.3929E-03	5.258	0.000	0.01	0.8
329.51	19.50	0.4520E-03	6.543	0.000	0.01	1.0
395.41	19.49	0.3204E-03	7.828	0.000	0.01	1.2
461.31	19.46	0.2290E-03	9.110	0.000	0.01	1.4
527.21	19.50	0.2419E-03	10.39	0.000	0.01	1.6
593.11	19.46	0.2878E-03	11.68	0.000	0.01	1.8
659.01	19.50	0.4118E-03	12.96	0.000	0.01	2.0
724.91	19.47	0.3440E-03	14.25	0.000	0.01	2.2
790.81	19.51	0.2578E-03	15.53	0.000	0.02	2.4
856.71	19.48	0.1879E-03	16.82	0.000	0.02	2.5
922.62	19.46	0.2447E-03	18.10	0.000	0.02	2.7
988.52	19.48	0.3005E-03	19.38	0.000	0.02	2.9
1054.42	19.46	0.3546E-03	20.66	0.000	0.02	3.1
1120.32	18.34	1.422	21.87	0.072	0.02	3.3
1186.22	18.26	1.525	23.08	0.077	0.02	3.5
1252.12	18.41	1.333	24.29	0.068	0.03	3.7
1318.02	17.05	3.156	25.41	0.156	0.03	3.9
1383.92	17.49	2.548	26.57	0.127	0.03	4.0
1449.82	15.77	4.760	27.60	0.232	0.03	4.2
1515.73	16.56	3.721	28.70	0.183	0.03	4.4
1581.63	15.65	4.896	29.73	0.238	0.03	4.5
1647.53	15.95	4.522	30.78	0.221	0.03	4.7
1713.43	15.38	5.278	31.79	0.255	0.03	4.8
1779.33	15.28	5.410	32.80	0.262	0.04	5.0
1845.23	14.84	5.936	33.78	0.286	0.04	5.1
1911.13	14.69	6.156	34.74	0.295	0.04	5.3
1977.03	14.39	6.511	35.69	0.312	0.04	5.4
2042.94	14.15	6.832	36.63	0.326	0.04	5.6
2108.84	13.84	7.243	37.54	0.344	0.04	5.7
2174.74	13.47	7.703	38.42	0.364	0.04	5.8
2240.64	13.17	8.094	39.29	0.381	0.05	6.0
2306.54	12.89	8.449	40.14	0.396	0.05	6.1
2372.44	12.61	8.836	40.97	0.412	0.05	6.2
2438.34	12.36	9.167	41.79	0.426	0.05	6.3
2504.24	12.08	9.519	42.58	0.441	0.05	6.5
2570.14	11.81	9.859	43.36	0.455	0.05	6.6
2636.05	11.58	10.14	44.12	0.467	0.05	6.7
2701.95	11.39	10.39	44.88	0.477	0.05	6.8
2767.85	11.20	10.65	45.61	0.488	0.06	6.9
2833.75	11.02	10.89	46.34	0.497	0.06	7.0
2899.65	10.81	11.13	47.05	0.507	0.06	7.1
2965.55	10.67	11.35	47.75	0.515	0.06	7.2
3031.45	10.46	11.58	48.44	0.525	0.06	7.3
3097.35	10.31	11.78	49.12	0.533	0.06	7.4
3163.25	10.11	12.02	49.79	0.543	0.06	7.6
3229.16	9.964	12.22	50.45	0.551	0.07	7.7
3295.06	9.793	12.46	51.09	0.560	0.07	7.7
3360.96	9.660	12.63	51.73	0.567	0.07	7.8
3426.86	9.501	12.84	52.36	0.575	0.07	7.9
3492.76	9.352	13.02	52.97	0.582	0.07	8.0
3558.66	9.221	13.18	53.58	0.588	0.07	8.1
3624.56	9.076	13.39	54.18	0.596	0.07	8.2
3690.46	8.954	13.54	54.77	0.602	0.07	8.3
3756.36	8.828	13.69	55.35	0.608	0.08	8.4
3822.27	8.700	13.86	55.92	0.614	0.08	8.5
3888.17	8.599	14.00	56.49	0.619	0.08	8.6
3954.07	8.479	14.15	57.05	0.625	0.08	8.7
4019.97	8.381	14.28	57.60	0.630	0.08	8.7
4085.87	8.246	14.43	58.14	0.636	0.08	8.8
4151.77	8.169	14.55	58.68	0.641	0.08	8.9
4217.67	8.056	14.69	59.21	0.646	0.09	9.0
4283.57	7.954	14.81	59.74	0.651	0.09	9.1
4349.48	7.865	14.94	60.26	0.655	0.09	9.1
4415.38	7.758	15.06	60.77	0.660	0.09	9.2
4481.28	7.692	15.16	61.27	0.663	0.09	9.3
4547.18	7.597	15.29	61.77	0.668	0.09	9.4
4613.08	7.503	15.40	62.27	0.672	0.09	9.4

4678.98	7.425	15.50	62.76	0.676	0.09	9.5
4744.88	7.342	15.60	63.24	0.680	0.10	9.6
4810.78	7.246	15.72	63.72	0.684	0.10	9.7
4876.69	7.180	15.81	64.19	0.688	0.10	9.7
4942.59	7.101	15.91	64.66	0.691	0.10	9.8
5008.49	7.024	16.00	65.12	0.695	0.10	9.9
5074.39	6.944	16.11	65.58	0.699	0.10	9.9
5140.29	6.880	16.18	66.03	0.702	0.10	10.0
5206.19	6.797	16.29	66.48	0.706	0.10	10.1
5272.09	6.738	16.37	66.93	0.708	0.11	10.1
5338.00	6.670	16.46	67.37	0.712	0.11	10.2
5403.90	6.613	16.55	67.80	0.715	0.11	10.3
5469.80	6.541	16.62	68.23	0.718	0.11	10.3
5535.70	6.476	16.69	68.66	0.720	0.11	10.4
5601.60	6.417	16.79	69.08	0.723	0.11	10.5
5667.50	6.368	16.85	69.50	0.726	0.11	10.5
5733.40	6.296	16.93	69.92	0.729	0.12	10.6
5799.31	6.266	16.99	70.33	0.731	0.12	10.7
5865.21	6.198	17.08	70.74	0.734	0.12	10.7
5931.11	6.147	17.13	71.14	0.736	0.12	10.8
5997.01	6.088	17.21	71.55	0.739	0.12	10.8
6062.91	6.033	17.26	71.94	0.741	0.12	10.9
6128.81	5.990	17.34	72.34	0.743	0.12	11.0
6194.71	5.951	17.39	72.73	0.743	0.12	11.0
6260.61	5.902	17.45	73.12	0.747	0.13	11.1
6326.52	5.846	17.51	73.50	0.750	0.13	11.1
6392.42	5.795	17.59	73.89	0.752	0.13	11.2
6458.32	5.769	17.62	74.27	0.753	0.13	11.3
6524.22	5.714	17.71	74.64	0.756	0.13	11.3
6590.12	5.685	17.74	75.02	0.757	0.13	11.4
6656.02	5.626	17.81	75.39	0.760	0.13	11.4
6721.92	5.593	17.84	75.76	0.761	0.14	11.5
6787.83	5.544	17.92	76.12	0.764	0.14	11.5
6853.73	5.510	17.96	76.48	0.765	0.14	11.6
6919.63	5.463	18.01	76.84	0.767	0.14	11.7
6985.53	5.431	18.06	77.20	0.769	0.14	11.7
7051.43	5.382	18.11	77.56	0.771	0.14	11.8
7117.33	5.357	18.15	77.91	0.772	0.14	11.8
7183.23	5.311	18.21	78.26	0.774	0.14	11.9
7249.14	5.272	18.25	78.61	0.776	0.15	11.9
7315.04	5.229	18.31	78.95	0.778	0.15	12.0
7380.94	5.209	18.33	79.30	0.779	0.15	12.0
7446.84	5.167	18.39	79.64	0.781	0.15	12.1
7512.74	5.131	18.43	79.97	0.782	0.15	12.1
7578.64	5.093	18.47	80.31	0.784	0.15	12.2
7644.54	5.055	18.52	80.64	0.786	0.15	12.2
7710.44	5.035	18.57	80.98	0.787	0.16	12.3
7776.35	4.999	18.61	81.30	0.788	0.16	12.3
7842.25	4.974	18.64	81.63	0.789	0.16	12.4
7908.15	7.939	18.70	81.96	0.791	0.16	12.4
7974.05	4.908	18.72	82.28	0.792	0.16	12.5
8039.95	4.884	18.76	82.60	0.793	0.16	12.5
8105.85	4.840	18.81	82.92	0.795	0.16	12.6
8171.75	4.823	18.85	83.24	0.796	0.16	12.6
8237.66	4.785	18.89	83.56	0.798	0.17	12.7
8303.56	4.765	18.91	83.87	0.799	0.17	12.7
8369.46	4.723	18.96	84.18	0.801	0.17	12.8
8435.36	4.702	18.98	84.49	0.801	0.17	12.8
8501.26	4.671	19.02	84.80	0.803	0.17	12.9
8567.16	4.655	19.05	85.10	0.804	0.17	12.9
8633.06	4.592	19.10	85.41	0.806	0.17	13.0
8698.96	4.592	19.12	85.71	0.806	0.18	13.0
8764.87	4.558	19.16	86.01	0.808	0.18	13.0
8830.77	4.541	19.20	86.31	0.809	0.18	13.1
8896.67	4.507	19.23	86.61	0.810	0.18	13.1
8962.57	4.480	19.26	86.90	0.811	0.18	13.2
9028.47	4.442	19.29	87.19	0.813	0.18	13.2

9094.37	4.433	19.32	87.49	0.813	0.18	13.3
9160.27	4.396	19.37	87.78	0.815	0.18	13.3
9226.18	4.384	19.39	88.07	0.816	0.19	13.4
9292.08	4.347	19.42	88.35	0.817	0.19	13.4
9357.98	4.328	19.45	88.64	0.818	0.19	13.4
9423.88	4.301	19.48	88.92	0.819	0.19	13.5
9489.78	4.284	19.50	89.20	0.820	0.19	13.5
9555.68	4.249	19.56	89.48	0.821	0.19	13.6
9621.58	4.243	19.57	89.76	0.822	0.19	13.6
9687.49	4.209	19.60	90.04	0.823	0.20	13.7
9753.39	4.201	19.62	90.32	0.824	0.20	13.7
9819.29	4.168	19.67	90.59	0.825	0.20	13.7
9885.19	4.154	19.68	90.87	0.826	0.20	13.8
9951.09	4.123	19.70	91.14	0.827	0.20	13.8
10016.99	4.101	19.73	91.41	0.828	0.20	13.9
10082.89	4.081	19.76	91.68	0.829	0.20	13.9
10148.79	4.044	19.78	91.94	0.830	0.20	13.9
10214.70	4.038	19.82	92.21	0.831	0.21	14.0
10280.60	4.015	19.85	92.47	0.832	0.21	14.0
10346.50	4.002	19.88	92.74	0.832	0.21	14.1
10412.40	3.977	19.90	93.00	0.833	0.21	14.1
10478.30	3.958	19.93	93.26	0.834	0.21	14.1
10544.20	3.936	19.95	93.52	0.835	0.21	14.2
10610.10	3.924	19.98	93.78	0.836	0.21	14.2
10676.01	3.884	20.00	94.03	0.837	0.22	14.3
10741.91	3.881	20.04	94.29	0.838	0.22	14.3
10807.81	3.869	20.06	94.54	0.838	0.22	14.3
10873.71	3.844	20.08	94.80	0.839	0.22	14.4
10939.61	3.823	20.11	95.05	0.840	0.22	14.4
11005.51	3.800	20.13	95.30	0.841	0.22	14.5
11071.41	3.790	20.15	95.55	0.842	0.22	14.5
11137.32	3.760	20.18	95.80	0.843	0.22	14.5
11203.22	3.762	20.19	96.05	0.843	0.23	14.6
11269.12	3.723	20.23	96.29	0.845	0.23	14.6
11335.02	3.725	20.25	96.54	0.845	0.23	14.6
11400.92	3.694	20.27	96.78	0.846	0.23	14.7
11466.82	3.676	20.29	97.02	0.847	0.23	14.7
11532.72	3.673	20.32	97.26	0.847	0.23	14.7
11598.63	3.658	20.33	97.51	0.848	0.23	14.8
11664.53	3.621	20.37	97.74	0.849	0.24	14.8
11730.43	3.608	20.38	97.98	0.850	0.24	14.9
11796.33	3.588	20.42	98.22	0.851	0.24	14.9
11862.23	3.590	20.43	98.45	0.851	0.24	14.9
11928.13	3.559	20.45	98.69	0.852	0.24	15.0
11994.03	3.549	20.47	98.92	0.852	0.24	15.0
12059.93	3.530	20.49	99.16	0.853	0.24	15.0
12125.84	3.514	20.50	99.39	0.854	0.24	15.1
12191.74	3.500	20.54	99.62	0.854	0.25	15.1
12257.64	3.491	20.53	99.85	0.855	0.25	15.1
12323.54	3.466	20.58	100.1	0.856	0.25	15.2
12389.44	3.450	20.58	100.3	0.856	0.25	15.2
12455.34	3.440	20.62	100.5	0.857	0.25	15.2
12521.24	3.430	20.64	100.8	0.857	0.25	15.3
12587.15	3.407	20.66	101.0	0.858	0.25	15.3
12653.05	3.412	20.68	101.2	0.858	0.26	15.3
12718.95	3.382	20.72	101.4	0.860	0.26	15.4
12784.85	3.375	20.69	101.7	0.860	0.26	15.4
12850.75	3.350	20.74	101.9	0.861	0.26	15.4
12916.65	3.348	20.74	102.1	0.861	0.26	15.5
12982.55	3.321	20.77	102.3	0.862	0.26	15.5
13048.46	3.313	20.78	102.5	0.863	0.26	15.5
13114.36	3.302	20.80	102.7	0.863	0.26	15.6
13180.26	3.278	20.82	103.0	0.864	0.27	15.6
13246.16	3.271	20.82	103.2	0.864	0.27	15.6
13312.06	3.253	20.86	103.4	0.865	0.27	15.7
13377.96	3.251	20.87	103.6	0.865	0.27	15.7
13443.86	3.223	20.89	103.8	0.866	0.27	15.7

13509.76	3.225	20.91	104.0	0.866	0.27	15.8
13575.67	3.210	20.94	104.2	0.867	0.27	15.8
13641.57	3.188	20.94	104.5	0.868	0.27	15.8
13707.47	3.173	20.94	104.7	0.868	0.28	15.9
13773.37	3.148	20.99	104.9	0.870	0.28	15.9
13839.27	3.151	20.98	105.1	0.869	0.28	15.9
13905.17	3.131	21.01	105.3	0.870	0.28	16.0
13971.07	3.118	21.01	105.5	0.871	0.28	16.0
14036.98	3.108	21.03	105.7	0.871	0.28	16.0
14102.88	3.083	21.07	105.9	0.872	0.28	16.1
14168.78	3.079	21.07	106.1	0.872	0.29	16.1
14234.68	3.062	21.08	106.3	0.873	0.29	16.1
14300.58	3.053	21.10	106.5	0.874	0.29	16.2
14366.48	3.047	21.10	106.7	0.874	0.29	16.2
14432.38	3.029	21.13	106.9	0.875	0.29	16.2
14498.29	3.014	21.14	107.1	0.875	0.29	16.2
14564.19	3.001	21.16	107.3	0.876	0.29	16.3
14630.09	2.994	21.19	107.5	0.876	0.29	16.3
14695.99	2.976	21.18	107.7	0.877	0.30	16.3
14761.89	2.965	21.21	107.9	0.877	0.30	16.4
14827.79	2.959	21.21	108.1	0.878	0.30	16.4
14893.69	2.924	21.25	108.3	0.879	0.30	16.4
14959.59	2.946	21.23	108.5	0.878	0.30	16.4
15025.50	2.909	21.27	108.7	0.880	0.30	16.5
15091.40	2.907	21.27	108.9	0.880	0.30	16.5
15157.30	2.889	21.31	109.0	0.881	0.31	16.5
15223.20	2.895	21.29	109.2	0.880	0.31	16.6
15289.10	2.872	21.32	109.4	0.881	0.31	16.6
15355.00	2.864	21.34	109.6	0.882	0.31	16.6
15420.90	2.855	21.35	109.8	0.882	0.31	16.7
15486.81	2.852	21.37	110.0	0.882	0.31	16.7
15552.71	2.828	21.39	110.2	0.883	0.31	16.7
15618.61	2.831	21.40	110.4	0.883	0.31	16.7
15684.51	2.804	21.41	110.5	0.884	0.32	16.8
15750.41	2.793	21.42	110.7	0.885	0.32	16.8
15816.31	2.785	21.43	110.9	0.885	0.32	16.8
15882.21	2.767	21.46	111.1	0.886	0.32	16.8
15948.12	2.772	21.46	111.3	0.886	0.32	16.9
16014.02	2.743	21.48	111.5	0.887	0.32	16.9
16079.92	2.743	21.47	111.6	0.887	0.32	16.9
16145.82	2.732	21.50	111.8	0.887	0.33	17.0
16211.72	2.727	21.51	112.0	0.887	0.33	17.0
16277.62	2.707	21.53	112.2	0.888	0.33	17.0
16343.52	2.696	21.56	112.4	0.889	0.33	17.0
16409.42	2.686	21.54	112.5	0.889	0.33	17.1
16475.32	2.675	21.58	112.7	0.890	0.33	17.1
16541.22	2.676	21.58	112.9	0.890	0.33	17.1
16607.13	2.650	21.61	113.1	0.891	0.33	17.1
16673.03	2.654	21.61	113.2	0.891	0.34	17.2
16738.93	2.630	21.63	113.4	0.892	0.34	17.2
16804.83	2.635	21.63	113.6	0.891	0.34	17.2
16870.73	2.622	21.66	113.8	0.892	0.34	17.3
16936.63	2.617	21.65	113.9	0.892	0.34	17.3
17002.53	2.601	21.68	114.1	0.893	0.34	17.3
17068.43	2.594	21.69	114.3	0.893	0.34	17.3
17134.33	2.587	21.70	114.4	0.893	0.35	17.4
17200.23	2.573	21.70	114.6	0.894	0.35	17.4
17266.13	2.565	21.72	114.8	0.894	0.35	17.4
17332.03	2.563	21.72	114.9	0.894	0.35	17.4
17397.93	2.536	21.74	115.1	0.896	0.35	17.5
17463.83	2.554	21.73	115.3	0.895	0.35	17.5
17529.73	2.529	21.79	115.5	0.896	0.35	17.5
17595.63	2.532	21.77	115.6	0.896	0.35	17.5
17661.53	2.504	21.79	115.8	0.897	0.36	17.6
17727.43	2.515	21.79	115.9	0.896	0.36	17.6
17793.33	2.480	21.84	116.1	0.898	0.36	17.6
17859.23	2.507	21.82	116.3	0.897	0.36	17.6

17925.13	2.467	21.84	116.4	0.898	0.36	17.7
17991.03	2.480	21.84	116.6	0.898	0.36	17.7
18056.93	2.454	21.87	116.8	0.899	0.36	17.7
18122.83	2.464	21.86	116.9	0.899	0.37	17.7
18188.73	2.432	21.88	117.1	0.900	0.37	17.8
18254.63	2.442	21.90	117.2	0.900	0.37	17.8
18320.54	2.430	21.89	117.4	0.900	0.37	17.8
18386.44	2.417	21.90	117.6	0.901	0.37	17.8
18452.34	2.405	21.92	117.7	0.901	0.37	17.9
18518.24	2.417	21.90	117.9	0.901	0.37	17.9
18584.14	2.371	21.96	118.0	0.903	0.37	17.9
18650.04	2.407	21.93	118.2	0.901	0.38	17.9
18715.94	2.370	21.97	118.4	0.903	0.38	17.9
18781.84	2.374	21.96	118.5	0.902	0.38	18.0
18847.74	2.344	21.99	118.7	0.904	0.38	18.0
18913.64	2.379	21.97	118.8	0.902	0.38	18.0
18979.54	2.326	22.02	119.0	0.904	0.38	18.0
19045.44	2.361	21.99	119.1	0.903	0.38	18.1
19111.34	2.317	22.02	119.3	0.905	0.39	18.1
19177.24	2.336	22.00	119.4	0.904	0.39	18.1
19243.14	2.293	22.06	119.6	0.906	0.39	18.1
19309.04	2.318	22.03	119.7	0.905	0.39	18.2
19374.94	2.295	22.07	119.9	0.906	0.39	18.2
19440.84	2.299	22.07	120.0	0.906	0.39	18.2
19506.74	2.288	22.06	120.2	0.906	0.39	18.2
19572.64	2.270	22.11	120.3	0.907	0.39	18.3
19638.54	2.282	22.09	120.5	0.906	0.40	18.3
19704.44	2.258	22.10	120.6	0.907	0.40	18.3
19770.34	2.259	22.11	120.8	0.907	0.40	18.3
19836.24	2.250	22.11	120.9	0.908	0.40	18.3
19902.14	2.238	22.13	121.1	0.908	0.40	18.4
19968.04	2.237	22.13	121.2	0.908	0.40	18.4
20033.95	2.229	22.16	121.4	0.909	0.40	18.4
20099.85	2.220	22.16	121.5	0.909	0.41	18.4
20165.75	2.214	22.18	121.7	0.909	0.41	18.5
20231.65	2.200	22.19	121.8	0.910	0.41	18.5
20297.55	2.206	22.17	122.0	0.909	0.41	18.5
20363.45	2.181	22.21	122.1	0.911	0.41	18.5
20429.35	2.182	22.21	122.3	0.911	0.41	18.5
20495.25	2.177	22.22	122.4	0.911	0.41	18.6
20561.15	2.161	22.25	122.5	0.911	0.41	18.6
20627.05	2.179	22.24	122.7	0.911	0.42	18.6
20692.95	2.144	22.25	122.8	0.912	0.42	18.6
20758.85	2.154	22.23	123.0	0.912	0.42	18.6
20824.75	2.138	22.27	123.1	0.912	0.42	18.7
20890.65	2.140	22.27	123.3	0.912	0.42	18.7
20956.55	2.130	22.28	123.4	0.913	0.42	18.7
21022.45	2.113	22.31	123.5	0.913	0.42	18.7
21088.35	2.121	22.29	123.7	0.913	0.43	18.8
21154.25	2.096	22.33	123.8	0.914	0.43	18.8
21220.15	2.106	22.31	123.9	0.914	0.43	18.8
21286.05	2.094	22.33	124.1	0.914	0.43	18.8
21351.95	2.087	22.34	124.2	0.915	0.43	18.8
21417.85	2.081	22.34	124.4	0.915	0.43	18.9
21483.75	2.061	22.36	124.5	0.916	0.43	18.9
21549.65	2.069	22.37	124.6	0.915	0.43	18.9
21615.55	2.065	22.36	124.8	0.915	0.44	18.9
21681.46	2.053	22.39	124.9	0.916	0.44	18.9
21747.36	2.046	22.39	125.0	0.916	0.44	19.0
21813.26	2.050	22.40	125.2	0.916	0.44	19.0
21879.16	2.036	22.41	125.3	0.917	0.44	19.0
21945.06	2.036	22.42	125.4	0.917	0.44	19.0
22010.96	2.011	22.42	125.6	0.918	0.44	19.0
22076.86	2.031	22.42	125.7	0.917	0.44	19.1
22142.76	2.000	22.45	125.8	0.918	0.45	19.1
22208.66	2.008	22.45	126.0	0.918	0.45	19.1
22274.56	1.989	22.45	126.1	0.919	0.45	19.1

22340.46	1.996	22.45	126.2	0.918	0.45	19.1
22406.36	1.972	22.49	126.4	0.919	0.45	19.2
22472.26	1.956	22.50	126.6	0.920	0.45	19.2
22538.16	1.995	22.45	126.5	0.918	0.45	19.2
22604.06	1.982	22.47	126.8	0.919	0.46	19.2
22669.96	1.946	22.51	126.9	0.920	0.46	19.2
22735.86	1.968	22.47	127.0	0.919	0.46	19.3
22801.76	1.940	22.53	127.1	0.921	0.46	19.3
22867.66	1.955	22.52	127.3	0.920	0.46	19.3
22933.56	1.925	22.53	127.4	0.921	0.46	19.3
22999.46	1.930	22.54	127.5	0.921	0.46	19.3
23065.36	1.923	22.55	127.7	0.921	0.46	19.4
23131.26	1.919	22.56	127.8	0.922	0.47	19.4
23197.16	1.919	22.56	127.9	0.922	0.47	19.4
23263.06	1.914	22.57	128.0	0.922	0.47	19.4
23328.96	1.904	22.59	128.2	0.922	0.47	19.4
23394.87	1.901	22.56	128.3	0.922	0.47	19.5
23460.77	1.890	22.60	128.4	0.923	0.47	19.5
23526.67	1.885	22.59	128.5	0.923	0.47	19.5
23592.57	1.882	22.61	128.7	0.923	0.48	19.5
23658.47	1.874	22.63	128.8	0.924	0.48	19.5
23724.37	1.875	22.62	128.9	0.923	0.48	19.5
23790.27	1.866	22.63	129.0	0.924	0.48	19.6
23856.17	1.866	22.63	129.1	0.924	0.48	19.6
23922.07	1.852	22.64	129.3	0.924	0.48	19.6
23987.97	1.849	22.65	129.4	0.925	0.48	19.6
24053.87	1.836	22.65	129.5	0.925	0.48	19.6
24119.77	1.847	22.66	129.6	0.925	0.49	19.7
24185.67	1.826	22.67	129.8	0.925	0.49	19.7
24251.57	1.820	22.68	129.9	0.926	0.49	19.7
24317.47	1.826	22.67	130.0	0.925	0.49	19.7
24383.37	1.816	22.69	130.1	0.926	0.49	19.7
24449.27	1.808	22.71	130.2	0.926	0.49	19.7
24515.17	1.810	22.69	130.4	0.926	0.49	19.8
24581.07	1.811	22.69	130.5	0.926	0.50	19.8
24646.97	1.780	22.73	130.6	0.927	0.50	19.8
24712.87	1.792	22.70	130.7	0.927	0.50	19.8
24778.77	1.766	22.76	130.8	0.928	0.50	19.8
24844.67	1.805	22.73	130.9	0.926	0.50	19.9
24910.57	1.763	22.77	131.1	0.928	0.50	19.9
24976.47	1.787	22.74	131.2	0.927	0.50	19.9
25042.38	1.765	22.77	131.3	0.928	0.50	19.9
25108.28	1.770	22.77	131.4	0.928	0.51	19.9
25174.18	1.754	22.77	131.5	0.929	0.51	19.9
25240.08	1.764	22.77	131.6	0.928	0.51	20.0
25305.98	1.739	22.79	131.8	0.929	0.51	20.0
25371.88	1.753	22.79	132.9	0.929	0.51	20.0
25437.78	1.738	22.79	132.0	0.929	0.51	20.0
25503.68	1.736	22.81	132.1	0.929	0.51	20.0
25569.58	1.737	22.81	132.2	0.929	0.52	20.0
25635.48	1.730	22.82	132.3	0.930	0.52	20.1
25701.38	1.722	22.83	132.4	0.930	0.52	20.1
25767.28	1.709	22.84	132.6	0.930	0.52	20.1
25833.18	1.708	22.82	132.7	0.930	0.52	20.1
25899.08	1.710	22.84	132.8	0.930	0.52	20.1
25964.98	1.699	22.84	132.9	0.931	0.52	20.2
26030.88	1.712	22.84	133.0	0.930	0.52	20.2
26096.78	1.676	22.88	133.1	0.932	0.53	20.2
26162.68	1.704	22.83	133.2	0.931	0.53	20.2
26228.58	1.672	22.88	133.3	0.932	0.53	20.2
26294.48	1.693	22.86	133.4	0.931	0.53	20.2
26360.38	1.659	22.90	133.6	0.932	0.53	20.3
26426.28	1.683	22.87	133.7	0.931	0.53	20.3
26492.18	1.653	22.90	133.8	0.933	0.53	20.3
26558.08	1.680	22.89	133.9	0.932	0.54	20.3
26623.98	1.637	22.92	134.0	0.933	0.54	20.3
26689.88	1.670	22.89	134.1	0.932	0.54	20.3

26755.79	1.634	22.93	134.2	0.933	0.54	20.4
26821.69	1.659	22.89	134.3	0.932	0.54	20.4
26887.59	1.632	22.93	134.4	0.934	0.54	20.4
26953.49	1.640	22.93	134.5	0.933	0.54	20.4
27019.39	1.629	22.95	134.6	0.934	0.54	20.4
27085.29	1.647	22.92	134.8	0.933	0.55	20.4
27151.19	1.614	22.96	134.9	0.934	0.55	20.5
27217.09	1.627	22.93	135.0	0.934	0.55	20.5
27282.99	1.608	22.98	135.1	0.935	0.55	20.5
27348.89	1.605	22.97	135.2	0.935	0.55	20.5
27414.79	1.614	22.94	135.3	0.934	0.55	20.5
27480.69	1.596	22.98	135.4	0.935	0.55	20.5
27546.59	1.608	22.96	135.5	0.935	0.56	20.5
27612.49	1.597	22.98	135.6	0.935	0.56	20.6
27678.39	1.595	22.98	135.7	0.935	0.56	20.6
27744.29	1.581	23.00	135.8	0.936	0.56	20.6
27810.19	1.585	23.00	135.9	0.936	0.56	20.6
27876.09	1.576	22.99	136.0	0.936	0.56	20.6
27941.99	1.578	22.99	136.1	0.936	0.56	20.6
28007.89	1.575	23.01	136.2	0.936	0.56	20.7
28073.79	1.557	23.02	136.3	0.937	0.57	20.7
28139.69	1.564	23.00	136.4	0.936	0.57	20.7
28205.59	1.556	23.04	136.5	0.937	0.57	20.7
28271.49	1.562	23.02	136.6	0.936	0.57	20.7
28337.39	1.548	23.04	136.7	0.937	0.57	20.7
28403.29	1.540	23.05	136.8	0.937	0.57	20.8
28469.20	1.544	23.04	136.9	0.937	0.57	20.8
28535.10	1.530	23.06	137.0	0.938	0.58	20.8
28601.00	1.534	23.05	137.1	0.938	0.58	20.8
28666.90	1.523	23.08	137.2	0.938	0.58	20.8
28732.80	1.534	23.07	137.3	0.938	0.58	20.8
28798.70	1.516	23.07	137.4	0.938	0.58	20.8
28864.60	1.523	23.07	137.5	0.938	0.58	20.9
28930.50	1.508	23.09	137.6	0.939	0.58	20.9
28996.40	1.518	23.07	137.7	0.938	0.58	20.9
29062.30	1.498	23.10	137.8	0.939	0.59	20.9
29128.20	1.522	23.09	137.9	0.938	0.59	20.9
29194.10	1.491	23.10	138.0	0.939	0.59	20.9
29260.00	1.504	23.09	138.1	0.939	0.59	20.9
29325.90	1.489	23.12	138.2	0.939	0.59	21.0
29391.80	1.493	23.11	138.3	0.939	0.59	21.0
29457.70	1.479	23.13	138.4	0.940	0.59	21.0
29523.60	1.489	23.13	138.5	0.940	0.60	21.0
29589.50	1.468	23.14	138.6	0.940	0.60	21.0
29655.40	1.491	23.12	138.7	0.939	0.60	21.0
29721.30	1.457	23.16	138.8	0.941	0.60	21.1
29787.20	1.479	23.12	138.9	0.940	0.60	21.1
29853.10	1.458	23.15	139.0	0.941	0.60	21.1
29919.00	1.466	23.15	139.1	0.940	0.60	21.1
29984.90	1.450	23.16	139.2	0.941	0.60	21.1
30050.80	1.450	23.16	139.3	0.941	0.61	21.1
30116.71	1.442	23.18	139.4	0.941	0.61	21.1
30182.61	1.437	23.17	139.5	0.942	0.61	21.2
30248.51	1.441	23.17	139.6	0.941	0.61	21.2
30314.41	1.422	23.18	139.7	0.942	0.61	21.2
30380.31	1.433	23.18	139.8	0.942	0.61	21.2
30446.21	1.422	23.20	139.9	0.942	0.61	21.2
30512.11	1.426	23.19	140.0	0.942	0.61	21.2
30578.01	1.414	23.21	140.1	0.943	0.62	21.2
30643.91	1.410	23.20	140.2	0.943	0.62	21.3
30709.81	1.411	23.20	140.2	0.943	0.62	21.3
30775.71	1.411	23.20	140.3	0.943	0.62	21.3
30841.61	1.401	23.22	140.4	0.943	0.62	21.3
30907.51	1.397	23.22	140.5	0.943	0.62	21.3
30973.41	1.400	23.22	140.6	0.943	0.62	21.3
31039.31	1.385	23.24	140.7	0.944	0.63	21.3
31105.21	1.398	23.24	140.8	0.943	0.63	21.4

31171.11	1.381	23.24	141.9	0.944	0.63	21.4
31237.01	1.387	23.23	141.0	0.944	0.63	21.4
31302.91	1.379	23.25	141.1	0.944	0.63	21.4
31368.81	1.377	23.27	141.2	0.944	0.63	21.4
31434.71	1.387	23.24	141.3	0.944	0.63	21.4
31500.61	1.361	23.26	141.3	0.945	0.63	21.4
31566.51	1.369	23.24	141.4	0.944	0.64	21.4
31632.41	1.364	23.28	141.5	0.945	0.64	21.5
31698.31	1.360	23.26	141.6	0.945	0.64	21.5
31764.21	1.357	23.26	141.7	0.945	0.64	21.5
31830.12	1.347	23.29	141.8	0.945	0.64	21.5
31896.02	1.359	23.27	141.9	0.945	0.64	21.5
31961.92	1.335	23.29	142.0	0.946	0.64	21.5
32027.82	1.346	23.27	142.1	0.945	0.65	21.5
32093.72	1.330	23.30	142.1	0.946	0.65	21.6
32159.62	1.336	23.30	142.2	0.946	0.65	21.6
32225.52	1.330	23.30	142.3	0.946	0.65	21.6
32291.42	1.335	23.30	142.4	0.946	0.65	21.6
32357.32	1.318	23.33	142.5	0.947	0.65	21.6
32423.22	1.327	23.33	142.6	0.946	0.65	21.6
32489.12	1.320	23.31	142.7	0.946	0.65	21.6
32555.02	1.312	23.34	142.8	0.947	0.66	21.6
32620.92	1.313	23.33	142.8	0.947	0.66	21.7
32686.82	1.307	23.32	142.9	0.947	0.66	21.7
32752.72	1.306	23.33	143.0	0.947	0.66	21.7
32818.62	1.301	23.34	143.1	0.947	0.66	21.7
32884.52	1.296	23.34	143.2	0.947	0.66	21.7
32950.43	1.299	23.35	143.3	0.947	0.66	21.7
33016.33	1.302	23.36	143.4	0.947	0.67	21.7
33082.23	1.287	23.36	143.4	0.948	0.67	21.8
33148.13	1.295	23.36	143.5	0.947	0.67	21.8
33214.04	1.280	23.36	143.6	0.948	0.67	21.8
33279.94	1.281	23.38	143.7	0.948	0.67	21.8
33345.84	1.275	23.38	143.8	0.948	0.67	21.8
33411.74	1.281	23.38	143.9	0.948	0.67	21.8
33477.64	1.264	23.38	144.0	0.949	0.67	21.8
33543.55	1.280	23.38	144.0	0.948	0.68	21.8
33609.45	1.262	23.41	144.1	0.949	0.68	21.9
33675.35	1.284	23.38	144.2	0.948	0.68	21.9
33741.25	1.251	23.41	144.3	0.949	0.68	21.9
33807.16	1.278	23.39	144.4	0.948	0.68	21.9
33873.06	1.250	23.40	144.5	0.949	0.68	21.9
33938.96	1.274	23.39	144.5	0.948	0.68	21.9
34004.86	1.246	23.43	144.6	0.949	0.69	21.9
34070.77	1.254	23.42	144.7	0.949	0.69	21.9
34136.67	1.241	23.44	144.8	0.950	0.69	22.0
34202.57	1.243	23.42	144.9	0.950	0.69	22.0
34268.47	1.244	23.43	144.9	0.950	0.69	22.0
34334.38	1.241	23.45	145.0	0.950	0.69	22.0
34400.28	1.238	23.44	145.1	0.950	0.69	22.0
34466.18	1.236	23.43	145.2	0.950	0.69	22.0
34532.08	1.233	23.44	145.3	0.950	0.70	22.0

PERFORMANCE VERSUS TIME FOR INFILL

TIME DAYS	OIL RATE STB/D	WATER RATE STB/D	CUMOIL MSTB	WCUT FRAC.	PV INJ FRAC.	OIL REC % OOIP
6392.42	2.731	25.80	73.89	0.904	0.13	
6425.37	15.66	30.40	74.40	0.660	0.13	11.3
6458.32	15.36	30.40	74.91	0.664	0.13	11.4
6491.27	15.33	30.40	75.41	0.665	0.13	11.4
6524.22	14.96	30.82	75.91	0.673	0.13	11.5
6557.17	14.97	30.81	76.40	0.673	0.14	11.6
6590.12	14.94	30.84	76.89	0.674	0.14	11.7
6623.07	15.05	30.69	77.39	0.671	0.14	11.7
6656.02	14.77	31.10	77.87	0.678	0.14	11.8
6688.97	15.09	30.66	78.37	0.670	0.14	11.9
6721.92	14.68	31.18	78.85	0.680	0.14	12.0
6754.88	15.02	30.77	79.35	0.672	0.14	12.0
6787.83	15.03	30.75	79.85	0.672	0.14	12.1
6820.78	14.85	30.99	80.33	0.676	0.15	12.2
6853.73	15.27	30.43	80.84	0.666	0.15	12.3
6886.68	14.65	31.24	81.32	0.681	0.15	12.3
6919.63	14.13	31.91	81.79	0.693	0.15	12.4
6952.58	13.90	32.22	82.24	0.699	0.15	12.5
6985.53	13.70	32.45	82.70	0.703	0.15	12.5
7018.48	13.51	32.70	83.14	0.708	0.15	12.6
7051.43	13.32	32.96	83.58	0.712	0.16	12.7
7084.38	13.11	33.22	84.01	0.717	0.16	12.7
7117.33	12.93	33.45	84.44	0.721	0.16	12.8
7150.28	12.76	33.67	84.86	0.725	0.16	12.9
7183.23	12.61	33.87	85.27	0.729	0.16	12.9
7216.18	12.45	34.06	85.68	0.732	0.16	13.0
7249.14	12.32	34.24	86.09	0.735	0.16	13.1
7282.09	12.18	34.41	86.49	0.739	0.16	13.1
7315.04	12.05	34.58	86.89	0.742	0.17	13.2
7347.99	11.96	34.73	87.28	0.744	0.17	13.2
7380.94	11.82	34.88	87.67	0.747	0.17	13.3
7413.89	11.71	35.02	88.06	0.749	0.17	13.4
7446.84	11.59	35.17	88.44	0.752	0.17	13.4
7479.79	11.48	35.30	88.82	0.755	0.17	13.5
7512.74	11.37	35.45	89.19	0.757	0.17	13.5
7545.69	11.26	35.59	89.56	0.760	0.18	13.6
7578.64	11.17	35.72	89.93	0.762	0.18	13.6
7611.59	11.05	35.84	90.30	0.764	0.18	13.7
7644.54	10.96	35.97	90.66	0.767	0.18	13.7
7677.49	10.85	36.11	91.01	0.769	0.18	13.8
7710.44	10.77	36.22	91.37	0.771	0.18	13.9
7743.40	10.67	36.36	91.72	0.773	0.18	13.9
7776.35	10.58	36.45	92.07	0.775	0.18	14.0
7809.30	10.49	36.57	92.41	0.777	0.19	14.0
7842.25	10.40	36.69	92.76	0.779	0.19	14.1
7875.20	10.33	36.78	93.10	0.781	0.19	14.1
7908.15	10.23	36.90	93.43	0.786	0.19	14.2
7941.10	10.17	37.00	93.77	0.784	0.19	14.2
7974.05	10.09	37.10	94.10	0.786	0.19	14.3
8007.00	10.00	37.20	94.43	0.788	0.19	14.3
8039.95	9.943	37.28	94.76	0.789	0.20	14.4
8072.90	9.860	37.39	95.08	0.791	0.20	14.4
8105.85	9.790	37.48	95.41	0.793	0.20	14.5
8138.80	9.719	37.56	95.73	0.794	0.20	14.5
8171.75	9.657	37.65	96.05	0.796	0.20	14.6
8204.71	9.585	37.74	96.36	0.797	0.20	14.6
8237.66	9.511	37.83	96.67	0.799	0.20	14.7
8270.61	9.460	37.90	96.99	0.800	0.20	14.7
8303.56	9.388	37.99	97.30	0.802	0.21	14.8
8336.51	9.329	38.06	97.60	0.803	0.21	14.8
8369.46	9.264	38.14	97.91	0.805	0.21	14.8
8402.41	9.198	38.22	98.21	0.806	0.21	14.9

8435.36	9.143	38.29	98.51	0.807	0.21	14.9
8468.31	9.090	38.37	98.81	0.808	0.21	15.0
8501.26	9.034	38.43	99.11	0.810	0.21	15.0
8534.21	8.974	38.51	99.41	0.811	0.22	15.1
8567.16	8.920	38.57	99.70	0.812	0.22	15.1
8600.11	8.868	38.63	99.99	0.813	0.22	15.2
8633.06	8.821	38.71	100.3	0.814	0.22	15.2
8666.01	8.766	38.77	100.6	0.816	0.22	15.2
8698.96	8.728	38.83	100.9	0.816	0.22	15.3
8731.91	8.665	38.90	101.1	0.818	0.22	15.3
8764.86	8.631	38.94	101.4	0.819	0.22	15.4
8797.81	8.559	39.04	101.7	0.820	0.23	15.4
8830.76	8.539	39.06	102.0	0.821	0.23	15.5
8863.71	8.480	39.14	102.3	0.822	0.23	15.5
8896.66	8.443	39.19	102.5	0.823	0.23	15.6
8929.61	8.398	39.26	102.8	0.824	0.23	15.6
8962.56	8.352	39.30	103.1	0.825	0.23	15.6
8995.51	8.310	39.36	103.4	0.826	0.23	15.7
9028.46	8.267	39.42	103.6	0.827	0.24	15.7
9061.41	8.225	39.46	103.9	0.828	0.24	15.8
9094.36	8.183	39.54	104.2	0.829	0.24	15.8
9127.31	8.154	39.56	104.5	0.829	0.24	15.8
9160.26	8.095	39.64	104.7	0.830	0.24	15.9
9193.21	8.075	39.67	105.0	0.831	0.24	15.9
9226.16	8.026	39.73	105.3	0.832	0.24	16.0
9259.11	7.993	39.77	105.5	0.833	0.24	16.0
9292.06	7.968	39.82	105.8	0.833	0.25	16.0
9325.01	7.916	39.87	106.0	0.834	0.25	16.1
9357.96	7.874	39.90	106.3	0.835	0.25	16.1
9390.91	7.841	39.96	106.6	0.836	0.25	16.2
9423.86	7.821	39.99	106.8	0.836	0.25	16.2
9456.81	7.765	40.05	107.1	0.838	0.25	16.2
9489.76	7.750	40.09	107.3	0.838	0.25	16.3
9522.71	7.705	40.12	107.6	0.839	0.26	16.3
9555.66	7.680	40.17	107.8	0.839	0.26	16.4
9588.61	7.641	40.21	108.1	0.840	0.26	16.4
9621.56	7.607	40.25	108.3	0.841	0.26	16.4
9654.51	7.569	40.32	108.6	0.842	0.26	16.5
9687.46	7.565	40.31	108.8	0.842	0.26	16.5
9720.41	7.499	40.39	109.1	0.843	0.26	16.5
9753.36	7.499	40.40	109.3	0.843	0.26	16.6
9786.31	7.442	40.48	109.6	0.845	0.27	16.6
9819.26	7.440	40.48	109.8	0.845	0.27	16.7
9852.21	7.385	40.55	110.1	0.846	0.27	16.7
9885.17	7.359	40.56	110.3	0.846	0.27	16.7
9918.12	7.333	40.60	110.5	0.847	0.27	16.8
9951.07	7.299	40.64	110.8	0.848	0.27	16.8
9984.02	7.276	40.67	111.0	0.848	0.27	16.8
10016.97	7.244	40.71	111.3	0.849	0.27	16.9
10049.92	7.223	40.75	111.5	0.849	0.28	16.9
10082.87	7.180	40.80	111.7	0.850	0.28	16.9
10115.82	7.178	40.82	112.0	0.850	0.28	17.0
10148.77	7.131	40.87	112.2	0.851	0.28	17.0
10181.72	7.123	40.90	112.4	0.852	0.28	17.1
10214.67	7.090	40.93	112.7	0.852	0.28	17.1
10247.62	7.055	40.97	112.9	0.856	0.28	17.1
10280.57	7.039	40.98	113.1	0.856	0.29	17.2
10313.52	7.007	41.03	113.4	0.854	0.29	17.2
10346.47	6.988	41.06	113.6	0.855	0.29	17.2
10379.42	6.962	41.07	113.8	0.855	0.29	17.3
10412.37	6.935	41.12	114.1	0.856	0.29	17.3
10445.32	6.914	41.15	114.3	0.856	0.29	17.3
10478.27	6.895	41.19	114.5	0.857	0.29	17.4
10511.22	6.865	41.22	114.7	0.857	0.29	17.4
10544.17	6.850	41.25	115.0	0.858	0.30	17.4
10577.12	6.823	41.27	115.2	0.858	0.30	17.5
10610.07	6.787	41.32	115.4	0.859	0.30	17.5

10643.02	6.769	41.33	115.6	0.859	0.30	17.5
10675.97	6.743	41.38	115.9	0.860	0.30	17.6
10708.92	6.727	41.39	116.1	0.860	0.30	17.6
10741.87	6.689	41.43	116.3	0.861	0.30	17.6
10774.82	6.682	41.44	116.5	0.861	0.31	17.7
10807.77	6.654	41.48	116.7	0.862	0.31	17.7
10840.72	6.642	41.50	117.0	0.862	0.31	17.7
10873.67	6.613	41.56	117.2	0.863	0.31	17.8
10906.62	6.598	41.55	117.4	0.863	0.31	17.8
10939.57	6.569	41.60	117.6	0.864	0.31	17.8
10972.52	6.554	41.61	117.8	0.864	0.31	17.9
11005.47	6.529	41.65	118.0	0.864	0.31	17.9
11038.42	6.508	41.67	118.3	0.865	0.32	17.9
11071.37	6.487	41.71	118.5	0.865	0.32	18.0
11104.32	6.470	41.72	118.7	0.866	0.32	18.0
11137.27	6.452	41.74	118.9	0.866	0.32	18.0
11170.22	6.427	41.77	119.1	0.867	0.32	18.1
11203.17	6.395	41.80	119.3	0.867	0.32	18.1
11236.12	6.381	41.83	119.5	0.868	0.32	18.1
11269.07	6.361	41.86	119.7	0.868	0.33	18.2
11302.02	6.345	41.88	120.0	0.868	0.33	18.2
11334.97	6.319	41.91	120.2	0.869	0.33	18.2
11367.92	6.299	41.93	120.4	0.869	0.33	18.3
11400.87	6.283	41.95	120.6	0.870	0.33	18.3
11433.82	6.269	41.99	120.8	0.870	0.33	18.3
11466.77	6.242	42.00	121.0	0.871	0.33	18.3
11499.72	6.217	42.04	121.2	0.871	0.33	18.4
11532.67	6.215	42.05	121.4	0.871	0.34	18.4
11565.63	6.191	42.09	121.6	0.872	0.34	18.4
11598.58	6.171	42.11	121.8	0.872	0.34	18.5
11631.53	6.155	42.12	122.0	0.873	0.34	18.5
11664.48	6.120	42.16	122.2	0.873	0.34	18.5
11697.43	6.115	42.16	122.4	0.873	0.34	18.6
11730.38	6.096	42.20	122.6	0.874	0.34	18.6
11763.33	6.083	42.22	122.8	0.874	0.35	18.6
11796.28	6.066	42.24	123.0	0.874	0.35	18.7
11829.23	6.049	42.27	123.2	0.875	0.35	18.7
11862.18	6.018	42.29	123.4	0.875	0.35	18.7
11895.13	6.001	42.30	123.6	0.876	0.35	18.7
11928.08	5.994	42.33	123.8	0.876	0.35	18.8
11961.03	5.968	42.35	124.0	0.876	0.35	18.8
11993.98	5.955	42.36	124.2	0.877	0.35	18.8
12026.93	5.939	42.41	124.4	0.877	0.36	18.9
12059.88	5.918	42.42	124.6	0.878	0.36	18.9
12092.83	5.894	42.44	124.8	0.878	0.36	18.9
12125.78	5.889	42.47	125.0	0.878	0.36	19.0
12158.73	5.864	42.48	125.2	0.879	0.36	19.0
12191.68	5.848	42.50	125.4	0.879	0.36	19.0
12224.63	5.838	42.54	125.6	0.879	0.36	19.0
12257.58	5.823	42.54	125.7	0.880	0.37	19.1
12290.53	5.809	42.57	125.9	0.880	0.37	19.1
12323.48	5.791	42.59	126.1	0.880	0.37	19.1
12356.43	5.770	42.61	126.3	0.881	0.37	19.2
12389.38	5.756	42.63	126.5	0.881	0.37	19.2
12422.33	5.739	42.65	126.7	0.881	0.37	19.2
12455.28	5.735	42.66	126.9	0.882	0.37	19.2
12488.23	5.709	42.70	127.1	0.882	0.37	19.3
12521.18	5.696	42.71	127.3	0.882	0.38	19.3
12554.13	5.681	42.73	127.5	0.883	0.38	19.3
12587.08	5.664	42.75	127.6	0.883	0.38	19.4
12620.03	5.661	42.77	127.8	0.883	0.38	19.4
12652.98	5.630	42.81	128.0	0.884	0.38	19.4
12685.93	5.626	42.80	128.2	0.884	0.38	19.4
12718.88	5.603	42.83	128.4	0.884	0.38	19.5
12751.83	5.585	42.85	128.6	0.885	0.39	19.5
12784.78	5.572	42.88	128.7	0.885	0.39	19.5
12817.73	5.556	42.89	128.9	0.885	0.39	19.6

12850.68	5.557	42.91	129.1	0.885	0.39	19.6
12883.63	5.529	42.92	129.3	0.886	0.39	19.6
12916.58	5.522	42.94	129.5	0.886	0.39	19.6
12949.53	5.502	42.96	129.7	0.886	0.39	19.7
12982.48	5.488	42.99	129.8	0.887	0.39	19.7
13015.43	5.479	42.99	130.0	0.887	0.40	19.7
13048.38	5.463	43.01	130.2	0.887	0.40	19.7
13081.33	5.450	43.02	130.4	0.888	0.40	19.8
13114.28	5.428	43.04	130.6	0.888	0.40	19.8
13147.23	5.410	43.06	130.7	0.888	0.40	19.8
13180.18	5.397	43.08	130.9	0.889	0.40	19.9
13213.13	5.380	43.10	131.1	0.889	0.40	19.9
13246.08	5.373	43.11	131.3	0.889	0.41	19.9
13279.04	5.359	43.14	131.4	0.889	0.41	19.9
13311.99	5.353	43.16	131.6	0.890	0.41	20.0
13344.94	5.328	43.18	131.8	0.890	0.41	20.0
13377.89	5.328	43.17	132.0	0.890	0.41	20.0
13410.84	5.305	43.21	132.1	0.891	0.41	20.0
13443.79	5.289	43.22	132.3	0.891	0.41	20.1
13476.74	5.289	43.23	132.5	0.891	0.41	20.1
13509.69	5.271	43.25	132.7	0.891	0.42	20.1
13542.64	5.264	43.26	132.8	0.892	0.42	20.1
13575.59	5.232	43.30	133.0	0.892	0.42	20.2
13608.54	5.235	43.30	133.2	0.892	0.42	20.2
13641.49	5.207	43.34	133.4	0.893	0.42	20.2
13674.44	5.218	43.32	133.5	0.892	0.42	20.2
13707.39	5.184	43.36	133.7	0.893	0.42	20.3
13740.34	5.190	43.36	133.9	0.893	0.43	20.3
13773.29	5.155	43.40	134.0	0.894	0.43	20.3
13806.24	5.165	43.41	134.2	0.894	0.43	20.4
13839.19	5.139	43.42	134.4	0.894	0.43	20.4
13872.14	5.125	43.43	134.6	0.894	0.43	20.4
13905.09	5.109	43.46	134.7	0.895	0.43	20.4
13938.04	5.101	43.47	134.9	0.895	0.43	20.5
13970.99	5.091	43.49	135.1	0.895	0.43	20.5
14003.94	5.072	43.50	135.2	0.896	0.44	20.5
14036.89	5.072	43.52	135.4	0.896	0.44	20.5
14069.84	5.054	43.54	135.6	0.896	0.44	20.6
14102.79	5.037	43.55	135.7	0.896	0.44	20.6
14135.74	5.030	43.57	135.9	0.897	0.44	20.6
14168.69	5.023	43.57	136.1	0.897	0.44	20.6
14201.64	5.001	43.61	136.2	0.897	0.44	20.7
14234.59	5.005	43.60	136.4	0.897	0.44	20.7
14267.54	4.969	43.65	136.5	0.898	0.45	20.7
14300.49	4.979	43.63	136.7	0.898	0.45	20.7
14333.44	4.956	43.66	136.9	0.898	0.45	20.8
14366.39	4.945	43.67	137.0	0.898	0.45	20.8
14399.34	4.933	43.69	137.2	0.899	0.45	20.8
14432.29	4.924	43.69	137.4	0.899	0.45	20.8
14465.24	4.919	43.72	137.5	0.899	0.45	20.9
14498.19	4.897	43.73	137.7	0.899	0.46	20.9
14531.14	4.889	43.75	137.8	0.899	0.46	20.9
14564.09	4.873	43.76	138.0	0.900	0.46	20.9
14597.04	4.870	43.79	138.2	0.900	0.46	21.0
14629.99	4.861	43.78	138.3	0.900	0.46	21.0
14662.94	4.842	43.81	138.5	0.900	0.46	21.0
14695.89	4.830	43.82	138.6	0.901	0.46	21.0
14728.84	4.817	43.83	138.8	0.901	0.46	21.0
14761.79	4.812	43.85	139.0	0.901	0.47	21.1
14794.74	4.794	43.86	139.1	0.901	0.47	21.1
14827.69	4.777	43.86	139.3	0.902	0.47	21.1
14860.64	4.778	43.89	139.4	0.902	0.47	21.1
14893.59	4.771	43.90	139.6	0.902	0.47	21.2
14926.54	4.764	43.91	139.8	0.902	0.47	21.2
14959.50	4.744	43.92	139.9	0.903	0.47	21.2
14992.45	4.745	43.93	140.1	0.903	0.48	21.2
15025.40	4.728	43.96	140.2	0.903	0.48	21.3

15058.35	4.719	43.97	140.4	0.903	0.48	21.3
15091.30	4.705	43.99	140.5	0.903	0.48	21.3
15124.25	4.701	44.01	140.7	0.903	0.48	21.3
15157.20	4.683	44.02	140.8	0.904	0.48	21.4
15190.15	4.688	44.00	141.0	0.904	0.48	21.4
15223.10	4.653	44.04	141.1	0.904	0.48	21.4
15256.05	4.661	44.03	141.3	0.904	0.49	21.4
15289.00	4.629	44.08	141.5	0.905	0.49	21.5
15321.95	4.639	44.06	141.6	0.905	0.49	21.5
15354.90	4.610	44.10	141.8	0.905	0.49	21.5
15387.85	4.613	44.08	141.9	0.905	0.49	21.5
15420.80	4.589	44.11	142.1	0.906	0.49	21.5
15453.75	4.596	44.11	142.2	0.906	0.49	21.6
15486.70	4.577	44.13	142.4	0.906	0.50	21.6
15519.65	4.568	44.15	142.5	0.906	0.50	21.6
15552.60	4.557	44.17	142.7	0.906	0.50	21.6
15585.55	4.541	44.20	142.8	0.907	0.50	21.7
15618.50	4.546	44.18	143.0	0.907	0.50	21.7
15651.45	4.530	44.21	143.1	0.907	0.50	21.7
15684.40	4.518	44.21	143.3	0.907	0.50	21.7
15717.35	4.515	44.21	143.4	0.907	0.50	21.7
15750.30	4.494	44.23	143.6	0.908	0.51	21.8
15783.25	4.491	44.24	143.7	0.908	0.51	21.8
15816.20	4.477	44.25	143.9	0.908	0.51	21.8
15849.15	4.465	44.27	144.0	0.908	0.51	21.8
15882.10	4.468	44.28	144.1	0.908	0.51	21.9
15915.05	4.442	44.32	144.3	0.909	0.51	21.9
15948.00	4.441	44.31	144.4	0.909	0.51	21.9
15980.95	4.421	44.34	144.6	0.909	0.52	21.9
16013.90	4.433	44.34	144.7	0.909	0.52	21.9
16046.85	4.416	44.36	144.9	0.909	0.52	22.0
16079.80	4.405	44.37	145.0	0.910	0.52	22.0
16112.75	4.398	44.38	145.2	0.910	0.52	22.0
16145.70	4.385	44.41	145.3	0.910	0.52	22.0
16178.65	4.383	44.41	145.5	0.910	0.52	22.1
16211.60	4.355	44.44	145.6	0.911	0.52	22.1
16244.55	4.373	44.43	145.7	0.910	0.53	22.1
16277.50	4.332	44.48	145.9	0.911	0.53	22.1
16310.45	4.360	44.44	146.0	0.911	0.53	22.1
16343.40	4.308	44.48	146.2	0.912	0.53	22.2
16376.35	4.327	44.48	146.3	0.911	0.53	22.2
16409.30	4.300	44.49	146.5	0.912	0.53	22.2
16442.26	4.310	44.49	146.6	0.912	0.53	22.2
16475.21	4.284	44.54	146.7	0.912	0.54	22.3
16508.16	4.294	44.53	146.9	0.912	0.54	22.3
16541.11	4.260	44.54	147.0	0.913	0.54	22.3
16574.06	4.271	44.53	147.2	0.912	0.54	22.3
16607.01	4.244	44.58	147.3	0.913	0.54	22.3
16639.96	4.268	44.56	147.4	0.913	0.54	22.4
16672.91	4.220	44.61	147.6	0.914	0.54	22.4
16705.87	4.249	44.58	147.7	0.913	0.54	22.4
16738.82	4.208	44.63	147.9	0.914	0.55	22.4
16771.77	4.226	44.60	148.0	0.913	0.55	22.4
16804.72	4.196	44.65	148.1	0.914	0.55	22.5
16837.67	4.214	44.62	148.3	0.914	0.55	22.5
16870.62	4.169	44.66	148.4	0.915	0.55	22.5
16903.57	4.182	44.66	148.6	0.914	0.55	22.5
16936.52	4.155	44.69	148.7	0.915	0.55	22.5
16969.47	4.176	44.66	148.8	0.914	0.56	22.6
17002.43	4.144	44.71	149.0	0.915	0.56	22.6
17035.38	4.158	44.69	149.1	0.915	0.56	22.6
17068.33	4.117	44.73	149.2	0.916	0.56	22.6
17101.28	4.141	44.73	149.4	0.915	0.56	22.7
17134.23	4.110	44.74	149.5	0.916	0.56	22.7
17167.18	4.117	44.75	149.6	0.916	0.56	22.7
17200.13	4.095	44.78	149.8	0.916	0.56	22.7
17233.08	4.101	44.76	149.9	0.916	0.57	22.7

17266.04	4.083	44.79	150.0	0.916	0.57	22.8
17298.99	4.080	44.79	150.2	0.917	0.57	22.8
17331.94	4.067	44.81	150.3	0.917	0.57	22.8
17364.89	4.065	44.82	150.5	0.917	0.57	22.8
17397.84	4.042	44.83	150.6	0.917	0.57	22.8
17430.79	4.044	44.84	150.7	0.917	0.57	22.9
17463.74	4.040	44.84	150.9	0.917	0.58	22.9
17496.69	4.011	44.87	151.0	0.918	0.58	22.9
17529.64	4.024	44.86	151.1	0.918	0.58	22.9
17562.60	4.004	44.88	151.2	0.918	0.58	22.9
17595.55	4.003	44.89	151.4	0.918	0.58	23.0
17628.50	3.983	44.91	151.5	0.919	0.58	23.0
17661.45	3.988	44.92	151.6	0.918	0.58	23.0
17694.40	3.973	44.93	151.8	0.919	0.58	23.0
17727.35	3.964	44.93	151.9	0.919	0.59	23.0
17760.30	3.958	44.94	152.0	0.919	0.59	23.1
17793.25	3.945	44.95	152.2	0.919	0.59	23.1
17826.21	3.936	44.98	152.3	0.920	0.59	23.1
17859.16	3.934	44.97	152.4	0.920	0.59	23.1
17892.11	3.924	44.99	152.6	0.920	0.59	23.1
17925.06	3.917	45.01	152.7	0.920	0.59	23.2
17958.01	3.917	45.00	152.8	0.920	0.60	23.2
17990.96	3.896	45.02	152.9	0.920	0.60	23.2
18023.91	3.891	45.03	153.1	0.920	0.60	23.2
18056.86	3.876	45.06	153.2	0.921	0.60	23.2
18089.81	3.884	45.05	153.3	0.921	0.60	23.3
18122.77	3.853	45.09	153.5	0.921	0.60	23.3
18155.72	3.865	45.07	153.6	0.921	0.60	23.3
18188.67	3.850	45.09	153.7	0.921	0.60	23.3
18221.62	3.841	45.09	153.8	0.921	0.61	23.3
18254.57	3.829	45.11	154.0	0.922	0.61	23.3
18287.52	3.829	45.11	154.1	0.922	0.61	23.4
18320.47	3.824	45.13	154.2	0.922	0.61	23.4
18353.42	3.811	45.14	154.3	0.922	0.61	23.4
18386.38	3.801	45.15	154.5	0.922	0.61	23.4
18419.33	3.783	45.16	154.6	0.923	0.61	23.4
18452.28	3.793	45.15	154.7	0.922	0.61	23.5
18485.23	3.765	45.18	154.8	0.923	0.62	23.5
18518.18	3.779	45.17	155.0	0.923	0.62	23.5
18551.13	3.764	45.19	155.1	0.923	0.62	23.5
18584.08	3.750	45.21	155.2	0.923	0.62	23.5
18617.03	3.757	45.20	155.3	0.923	0.62	23.6
18649.98	3.740	45.24	155.5	0.924	0.62	23.6
18682.94	3.727	45.23	155.6	0.924	0.62	23.6
18715.89	3.730	45.25	155.7	0.924	0.63	23.6
18748.84	3.715	45.27	155.8	0.924	0.63	23.6
18781.79	3.723	45.26	155.9	0.924	0.63	23.6
18814.74	3.704	45.29	156.1	0.924	0.63	23.7
18847.69	3.694	45.29	156.2	0.925	0.63	23.7
18880.64	3.691	45.29	156.3	0.925	0.63	23.7
18913.59	3.672	45.29	156.4	0.925	0.63	23.7
18946.54	3.670	45.32	156.6	0.925	0.63	23.7
18979.50	3.673	45.33	156.7	0.925	0.64	23.8
19012.45	3.672	45.33	156.8	0.925	0.64	23.8
19045.40	3.644	45.36	156.9	0.926	0.64	23.8
19078.35	3.656	45.34	157.0	0.925	0.64	23.8
19111.30	3.639	45.35	157.2	0.926	0.64	23.8
19144.25	3.628	45.38	157.3	0.926	0.64	23.8
19177.20	3.640	45.38	157.4	0.926	0.64	23.9
19210.15	3.609	45.40	157.5	0.926	0.65	23.9
19243.11	3.617	45.40	157.6	0.926	0.65	23.9
19276.06	3.604	45.40	157.8	0.926	0.65	23.9
19309.01	3.597	45.42	157.9	0.927	0.65	23.9
19341.98	3.580	45.44	158.0	0.927	0.65	24.0
19374.91	3.594	45.43	158.1	0.927	0.65	24.0
19407.86	3.578	45.44	158.2	0.927	0.65	24.0
19440.81	3.565	45.46	158.3	0.927	0.65	24.0

19473.76	3.560	45.47	158.5	0.927	0.66	24.0
19506.71	3.549	45.48	158.6	0.928	0.66	24.0
19539.67	3.547	45.47	158.7	0.928	0.66	24.1
19572.62	3.545	45.49	158.8	0.928	0.66	24.1
19605.57	3.526	45.50	158.9	0.928	0.66	24.1
19638.52	3.533	45.50	159.0	.0928	0.66	24.1
19671.47	3.499	45.53	159.2	.0929	0.66	24.1
19704.42	3.520	45.50	159.3	.0928	0.67	24.2
19737.37	3.495	45.55	159.4	.0929	0.67	24.2
19770.32	3.509	45.53	159.5	.0928	0.67	24.2
19803.28	3.483	45.56	159.6	.0929	0.67	24.2
19836.23	3.494	45.55	159.7	.0929	0.67	24.2
19869.18	3.480	45.56	159.8	0.929	0.67	24.2
19902.13	3.478	45.56	160.0	0.929	0.67	24.3
19935.08	3.463	45.59	160.1	0.929	0.67	24.3
19968.03	3.464	45.59	160.2	0.929	0.68	24.3
20000.98	3.450	45.59	160.3	0.930	0.68	24.3
20033.93	3.444	45.60	160.4	0.930	0.68	24.3
20066.88	3.441	45.62	160.5	0.930	0.68	24.3
20099.84	3.432	45.62	160.6	0.930	0.68	24.4
20132.79	3.417	45.64	160.8	0.930	0.68	24.4
20165.74	3.425	45.64	160.9	0.930	0.68	24.4
20198.69	3.406	45.67	161.0	0.931	0.69	24.4
20231.64	3.415	45.65	161.1	0.930	0.69	24.4
20264.59	3.403	45.66	161.2	0.931	0.69	24.4
20297.54	3.401	45.68	161.3	0.931	0.69	24.5
20330.49	3.386	45.69	161.4	0.931	0.69	24.5
20363.45	3.394	45.68	161.5	0.931	0.69	24.5
20396.40	3.380	45.71	161.7	0.931	0.69	24.5
20429.35	3.381	45.70	161.8	0.931	0.69	24.5
20462.30	3.360	45.72	161.9	0.932	0.70	24.5
20495.25	3.360	45.70	162.0	0.932	0.70	24.6
20528.20	3.342	45.73	162.1	0.932	0.70	24.6
20561.15	3.362	45.72	162.2	0.931	0.70	24.6
20594.10	3.327	45.77	162.3	0.932	0.70	24.6
20627.05	3.345	45.72	162.4	0.932	0.70	24.6
20660.01	3.316	45.78	162.5	0.932	0.70	24.6
20692.96	3.342	45.75	162.6	0.932	0.71	24.7
20725.91	3.303	45.79	162.8	0.933	0.71	24.7
20758.86	3.316	45.77	162.9	0.932	0.71	24.7
20791.81	3.289	45.79	163.0	0.933	0.71	24.7
20824.76	3.305	45.78	163.1	0.933	0.71	24.7
20857.71	3.268	45.82	163.2	0.933	0.71	24.7
20890.66	3.304	45.79	163.3	0.933	0.71	24.8
20923.62	3.266	45.85	163.4	0.933	0.71	24.8
20956.57	3.291	45.82	163.5	0.933	0.72	24.8
20989.52	3.252	45.85	163.6	0.934	0.72	24.8
21022.47	3.284	45.82	163.7	0.933	0.72	24.8
21055.42	3.245	45.86	163.8	0.934	0.72	24.8
21088.37	3.263	45.85	163.9	0.934	0.72	24.9
21121.32	3.231	45.89	164.1	0.934	0.72	24.9
21154.27	3.248	45.86	164.2	0.934	0.72	24.9
21187.22	3.225	45.87	164.3	0.934	0.73	24.9
21220.18	3.225	45.90	164.4	0.934	0.73	24.9
21253.13	3.221	45.89	164.5	0.934	0.73	24.9
21286.08	3.220	45.90	164.6	0.934	0.73	25.0
21319.03	3.202	45.91	164.7	0.935	0.73	25.0
21351.98	3.202	45.92	164.8	0.935	0.73	25.0
21384.93	3.194	45.95	164.9	0.935	0.73	25.0
21417.88	3.204	45.92	165.0	0.935	0.73	25.0
21450.83	3.176	45.97	165.1	0.935	0.74	25.0
21483.79	3.206	45.93	165.2	0.935	0.74	25.1
21516.74	3.156	45.99	165.3	0.936	0.74	25.1
21549.69	3.192	45.94	165.4	0.935	0.74	25.1
21582.64	3.153	45.98	165.5	0.936	0.74	25.1
51615.59	3.166	45.96	165.6	0.936	0.74	25.1
21648.54	3.142	46.00	165.7	0.936	0.74	25.1

21681.49	3.149	45.97	165.8	0.936	0.75	25.1
21714.44	3.126	46.00	165.9	0.936	0.75	25.2
21747.39	3.150	45.98	166.0	0.936	0.75	25.2
21780.35	3.123	46.01	166.1	0.936	0.75	25.2
21813.30	3.136	45.99	166.3	0.936	0.75	25.2
21846.25	3.117	46.03	166.4	0.937	0.75	25.2
21879.20	3.118	46.01	166.5	0.937	0.75	25.2
21912.15	3.114	46.04	166.6	0.937	0.75	25.3
21945.10	3.095	46.06	166.7	0.937	0.76	25.3
21978.05	3.117	46.03	166.8	0.937	0.76	25.3
22011.00	3.077	46.09	166.9	0.937	0.76	25.3
22043.96	3.111	46.05	167.0	0.937	0.76	25.3
22076.91	3.080	46.08	167.1	0.937	0.76	25.3
22109.86	3.089	46.08	167.2	0.937	0.76	25.4
22142.81	3.079	46.09	167.3	0.937	0.76	25.4
22175.76	3.074	46.09	167.4	0.937	0.77	25.4
22208.71	3.071	46.09	167.5	0.938	0.77	25.4
22241.66	3.064	46.11	167.6	0.938	0.77	25.4
22274.66	3.066	46.10	167.7	0.938	0.77	25.4
22307.56	3.051	46.12	167.8	0.938	0.77	25.4
22340.52	3.058	46.11	167.9	0.938	0.77	25.5
22373.47	3.035	46.14	168.0	0.938	0.77	25.5
22406.42	3.045	46.12	168.1	0.938	0.77	25.5
22439.37	3.020	46.16	168.2	0.939	0.78	25.5
22472.32	3.032	46.14	168.3	0.938	0.78	25.5
22505.27	3.031	46.15	168.4	0.938	0.78	25.5
22538.22	3.007	46.17	168.5	0.939	0.78	25.5
22571.17	3.024	46.15	168.6	0.938	0.78	25.6
22604.13	3.002	46.18	168.7	0.939	0.78	25.6
22637.08	3.012	46.16	168.8	0.939	0.78	25.6
22670.03	2.984	46.21	168.9	0.939	0.78	25.6
22702.98	3.003	46.19	169.0	0.939	0.79	25.6
22735.93	2.975	46.22	169.1	0.940	0.79	25.6
22768.88	2.986	46.21	169.2	0.939	0.79	25.7
22801.83	2.983	46.22	169.3	0.939	0.79	25.7
22834.78	2.966	46.22	169.4	0.940	0.79	25.7
22867.73	2.963	46.23	169.5	0.940	0.79	25.7
22900.69	2.960	46.23	169.6	0.940	0.79	25.7
22933.64	2.955	46.25	169.7	0.940	0.80	25.7
22966.59	2.951	46.25	169.8	0.940	0.80	25.7
22999.54	2.943	46.26	169.9	0.940	0.80	25.8
23032.49	2.942	46.26	169.9	0.940	0.80	25.8
23065.44	2.924	46.27	170.0	0.941	0.80	25.8
23098.39	2.931	46.27	170.1	0.940	0.80	25.8
23131.34	2.928	46.28	170.2	0.941	0.80	25.8
23164.29	2.923	46.29	170.3	0.941	0.80	25.8
23197.25	2.912	46.31	170.4	0.941	0.81	25.8
23230.20	2.893	46.32	170.5	0.941	0.81	25.9
23263.15	2.923	46.29	170.6	0.941	0.81	25.9
23296.10	2.896	46.33	170.7	0.941	0.81	25.9
23329.05	2.898	46.32	170.8	0.941	0.81	25.9
23362.00	2.888	46.35	170.9	0.941	0.81	25.9
23394.95	2.894	46.34	171.0	0.941	0.81	25.9
23427.90	2.875	46.36	171.1	0.942	0.82	25.9
23460.86	2.887	46.34	171.2	0.941	0.82	26.0
23493.81	2.865	46.36	171.3	0.942	0.82	26.0
23526.76	2.873	46.36	171.4	0.942	0.82	26.0
23559.71	2.858	46.36	171.5	0.942	0.82	26.0
23592.66	2.865	46.37	171.6	0.942	0.82	26.0
23625.61	2.840	46.39	171.7	0.942	0.82	26.0
23658.56	2.854	46.37	171.8	0.942	0.82	26.0
23691.51	2.844	46.39	171.9	0.942	0.83	26.1
23724.46	2.842	46.40	171.9	0.942	0.83	26.1
23757.42	2.828	46.41	172.0	0.943	0.83	26.1
23790.37	2.844	46.39	172.1	0.942	0.83	26.1
23823.32	2.813	46.42	172.2	0.943	0.83	26.1
23856.27	2.822	46.42	172.3	0.943	0.83	26.1

23889.22	2.798	46.44	172.4	0.943	0.83	26.1
23922.17	2.815	46.42	172.5	0.943	0.84	26.2
23955.12	2.800	46.44	172.6	0.943	0.84	26.2
23988.07	2.790	46.46	172.7	0.943	0.84	26.2
24021.03	2.792	46.46	172.8	0.943	0.84	26.2
24053.98	2.796	46.46	172.9	0.943	0.84	26.2
24086.93	2.758	46.47	173.0	0.944	0.84	26.2
24119.88	2.790	46.44	173.1	0.943	0.84	26.2
24152.83	2.757	46.48	173.1	0.944	0.84	26.3
24185.78	2.778	46.47	173.2	0.944	0.85	26.3
24218.73	2.744	46.51	173.3	0.944	0.85	26.3
24251.68	2.763	46.48	173.4	0.944	0.85	26.3
24284.63	2.750	46.50	173.5	0.944	0.85	26.3
24317.59	2.747	46.50	173.6	0.944	0.85	26.3
24350.54	2.732	46.52	173.7	0.945	0.85	26.3
24383.49	2.747	46.51	173.8	0.944	0.85	26.4
24416.44	2.729	46.53	173.9	0.945	0.86	26.4
24449.39	2.729	46.53	174.0	0.945	0.86	26.4
24482.34	2.724	46.57	174.1	0.945	0.86	26.4
24515.29	2.730	46.54	174.1	0.945	0.86	26.4
24548.24	2.710	46.55	174.2	0.945	0.86	26.4
24581.20	2.714	46.54	174.3	0.945	0.86	26.4
24614.15	2.695	46.56	174.4	0.945	0.86	26.4
24647.10	2.707	46.55	174.5	0.945	0.86	26.5
24680.05	2.693	46.57	174.6	0.945	0.87	26.5
24713.00	2.683	46.60	174.7	0.946	0.87	26.5
24745.95	2.699	46.58	174.8	0.945	0.87	26.5
24778.90	2.675	46.61	174.9	0.946	0.87	26.5
24811.85	2.669	46.62	174.9	0.946	0.87	26.5
24844.80	2.671	46.60	175.0	0.946	0.87	26.5
24877.76	2.667	46.62	175.1	0.946	0.87	26.6
24910.71	2.669	46.60	175.2	0.946	0.88	26.6
24943.66	2.657	46.61	175.3	0.946	0.88	26.6
24976.61	2.656	46.61	175.4	0.946	0.88	26.6
25009.56	2.646	46.64	175.5	0.946	0.88	26.6
25042.51	2.646	46.61	175.6	0.946	0.88	26.6
25075.46	2.633	46.66	175.6	0.947	0.88	26.6
25108.41	2.647	46.63	175.7	0.946	0.88	26.6
25141.37	2.621	46.65	175.8	0.947	0.88	26.7
25174.32	2.628	46.68	175.9	0.947	0.89	26.7
25207.27	2.625	46.67	176.0	0.947	0.89	26.7
25240.22	2.630	46.66	176.1	0.947	0.89	26.7
25273.17	2.605	46.70	176.2	0.947	0.89	26.7
25306.12	2.626	46.67	176.2	0.947	0.89	26.7
25339.07	2.601	46.71	176.3	0.947	0.89	26.7
25372.02	2.610	46.67	176.4	0.947	0.89	26.8
25404.97	2.590	46.72	176.5	0.947	0.90	26.8
25437.93	2.610	46.70	176.6	0.947	0.90	26.8
25470.88	2.577	46.73	176.7	0.948	0.90	26.8
25503.83	2.599	46.71	176.8	0.947	0.90	26.8
25536.78	2.570	46.75	176.8	0.948	0.90	26.8
25569.73	2.578	46.71	176.9	0.948	0.90	26.8
25602.68	2.566	46.73	177.0	0.948	0.90	26.8
25635.63	2.577	46.71	177.1	0.948	0.90	26.9
25668.58	2.550	46.76	177.2	0.948	0.91	26.9
25701.54	2.573	46.71	177.3	0.948	0.91	26.9
25734.49	2.529	46.77	177.3	0.949	0.91	26.9
25767.44	2.573	46.72	177.4	0.948	0.91	26.9
25800.39	2.532	46.78	177.5	0.949	0.91	26.9
25833.34	2.556	46.74	177.6	0.948	0.91	26.9
25866.29	2.524	46.78	177.7	0.949	0.91	26.9
25899.24	2.536	46.76	177.8	0.949	0.92	27.0
25932.19	2.520	46.80	177.9	0.949	0.92	27.0
25965.14	2.529	46.76	177.9	0.949	0.92	27.0
25998.10	2.507	46.79	178.0	0.949	0.92	27.0
26031.05	2.524	46.78	178.1	0.949	0.92	27.0
26064.00	2.498	46.81	178.2	0.949	0.92	27.0

26096.95	2.515	46.81	178.3	0.949	0.92	27.0
26129.90	2.487	46.83	178.3	0.950	0.92	27.0
26162.85	2.518	46.81	178.4	0.949	0.93	27.1
26195.80	2.484	46.85	178.5	0.950	0.93	27.1
26228.75	2.506	46.82	178.6	0.949	0.93	27.1
26261.71	2.487	46.84	178.7	0.950	0.93	27.1
26294.66	2.495	46.85	178.8	0.949	0.93	27.1
26327.61	2.477	46.86	178.8	0.950	0.93	27.1
26360.56	2.468	46.85	178.9	0.950	0.93	27.1
26393.51	2.469	46.85	179.0	0.950	0.94	27.1
26426.46	2.469	46.83	179.1	0.950	0.94	27.2
26459.41	2.460	46.87	179.2	0.950	0.94	27.2

TOTAL PATTERN RESULTS:

WATERFLOOD RECOVERY	1162.20	MSTB
WATERFLOOD+INFILL RECOVERY :	1433.33	MSTB
INCREMENTAL OIL FROM INFILL:	271.13	MSTB
INCREMENTAL OIL FROM INFILL:	5.14	% OOIP
ORIGINAL OIL IN PLACE :	5275.44	MSTB

S C I E N T I F I C S O F T W A R E
- I N T E R C O M P

INFILL DRILLING PREDICTION MODEL
(IDPM - RELEASE 1.2.0)

Economics for Waterflood

ECONOMIC DATA		
NUMBER OF PROJECT YEARS	40	
STATE CODE	NONE	
DISTRICT CODE	0	
PRINT CONTROL	2	IOUT
FEDERAL INCOME TAX OPTION	0	IFIT
DISCOUNTING METHOD	0	IDISC
DEPRECIATION METHOD	0	IDEP
PROJECT ECONOMIC LIFE METHOD	0	IPLIF
RESERVOIR DEPTH	6300.0	FEET
INJECTORS DRILLED PER PATTERN (WPP1)	1.00	
PRODUCERS DRILLED PER PATTERN (WPP2)	1.00	
CONVTD PRIMARY PROD PER PAT (WPP3)	0.00	
CONVTD PROD TO INJ PER PAT (WPP4)	0.00	
NO. OF MONTHS WORKING CAPITAL	0.00	
PROJECT STARTUP COSTS	0.0	M$
OIL RATE UNCERTAINTY	0.0010	FRACTION
PERCENT OF CAPITAL BORROWED	0	PERCENT
TAXES AND ESCALATION		
DISCOUNT RATE	0.100	FRACTION
INFLATION RATE	0.050	FRACTION
ROYALTY RATE	0.125	FRACTION
SEVERANCE TAX RATE	0.080	FRACTION
FEDERAL INCOME TAX RATE	0.460	FRACTION
INVESTMENT TAX CREDIT	0.100	FRACTION
DEPRECIATION TIME (STRAIGHT LINE)	5.00	YEARS
STATE INCOME TAX RATE	0.040	FRACTION
WINDFALL EXCISE TAX RATE	0.00	FRACTION
WINDFALL PHASE OUT START DATE	1991.	
WINDFALL PHASE OUT END DATE	1993.	
PROJECT START DATE	1994.	
BASE OIL PRICE FOR WINDFALL TAX	23.07	$/BBL
OIL PRICE ESCALATION RATE	0.000	FRACTION
GAS PRICE ESCALATION RATE	0.000	FRACTION
OPERATING COST ESCALATION RATE	0.000	FRACTION

PRICES AND COSTS		LOW	MOST-LIKELY	HIGH
OIL PRICE	$/BBL	16.00	20.00	24.00
GAS PRICE	$/MCF	2.67	3.33	4.00
FIXED OPERATING COST PER PATTERN	$/YR	33313.	41642.	49970.
VARIABLE OPERATING COST	$/BBL	.040	.050	.060
WELL WORKOVER COST PER PATTERN	$/YR		12013.	
PROD WATER TREATING/DISPOSAL COST	$/BBL		.030	

NOTE.. -PATTERN- HERE ALWAYS REFERS TO THE PRE-INFILL FULL 5-SPOT PATTERN

ANNUAL PATTERN AND PROJECT VOLUMES PRODUCED

PROJECT LIFE IS 40 YEARS

	--------------PATTERN-------------					------------------PROJECT--------------				
YR	OIL, MSTB	GAS, MMSCF	WATER, MSTB	YR-END WTR-CUT	INJ WTR, MSTB	PATTERNS INITIATD	PATTERNS TOTAL	OIL, MSTB	GAS, MMSCF	WATER, MSTB
1	57.9	19.1	0.0	0.0000	73.1	6.	6.	347.5	114.7	0.0
2	56.9	18.8	0.0	0.0000	73.1	0.	6.	341.5	112.7	0.0
3	56.5	18.7	0.5	0.0451	73.1	0.	6.	339.2	111.9	2.8
4	50.9	16.8	7.6	0.2237	73.1	0.	6.	305.7	100.9	45.8
5	45.6	15.1	14.5	0.2787	73.1	0.	6.	273.9	90.4	86.7
6	41.2	13.6	20.1	0.3681	73.1	0.	6.	247.2	81.6	120.9
7	36.5	12.0	26.3	0.4522	73.1	0.	6.	218.8	72.2	157.7
8	32.7	10.8	31.1	0.5100	73.1	0.	6.	196.2	64.7	186.8
9	29.8	9.8	34.8	0.5589	73.1	0.	6.	178.8	59.0	209.1
10	27.3	9.0	38.1	0.5985	73.1	0.	6.	163.7	54.0	228.6
11	25.2	8.3	40.8	0.6300	73.1	0.	6.	151.4	50.0	244.5
12	23.5	7.7	43.0	0.6575	73.1	0.	6.	140.8	46.5	258.0
13	22.0	7.3	44.9	0.6803	73.1	0.	6.	132.0	43.6	269.4
14	20.7	6.8	46.6	0.7005	73.1	0.	6.	124.0	40.9	279.5
15	19.5	6.4	48.0	0.7180	73.1	0.	6.	117.2	38.7	288.3
16	18.5	6.1	49.3	0.7327	73.1	0.	6.	111.2	36.7	296.0
17	17.7	5.8	50.4	0.7456	73.1	0.	6.	106.0	35.0	302.6
18	16.9	5.6	51.4	0.7570	73.1	0.	6.	101.4	33.5	308.6
19	16.2	5.3	52.3	0.7677	73.1	0.	6.	97.2	32.1	314.0
20	15.6	5.1	53.1	0.7776	73.1	0.	6.	93.4	30.8	318.8
21	15.0	4.9	53.9	0.7860	73.1	0.	6.	89.9	29.7	323.2
22	14.5	4.8	54.6	0.7934	73.1	0.	6.	86.8	28.6	327.4
23	14.0	4.6	55.2	0.8010	73.1	0.	6.	83.8	27.7	331.2
24	13.5	4.5	55.8	0.8079	73.1	0.	6.	81.0	26.7	334.5
25	13.1	4.3	56.3	0.8143	73.1	0.	6.	78.4	25.9	337.8
26	12.7	4.2	56.8	0.8200	73.1	0.	6.	76.0	25.1	340.9
27	12.3	4.1	57.3	0.8255	73.1	0.	6.	73.7	24.3	343.8
28	11.9	3.9	57.7	0.8309	73.1	0.	6.	71.5	23.6	346.4
29	11.6	3.8	58.2	0.8357	73.1	0.	6.	69.6	23.0	349.1
30	11.3	3.7	58.6	0.8405	73.1	0.	6.	67.7	22.3	351.6
31	11.0	3.6	59.0	0.8446	73.1	0.	6.	65.9	21.7	354.0
32	10.7	3.5	59.4	0.8493	73.1	0.	6.	64.2	21.2	356.2
33	10.4	3.4	59.7	0.8529	73.1	0.	6.	62.6	20.6	358.4
34	10.2	3.4	60.0	0.8567	73.1	0.	6.	61.0	20.1	360.3
35	9.9	3.3	60.4	0.8598	73.1	0.	6.	59.7	19.7	362.4
36	9.7	3.2	60.7	0.8635	73.1	0.	6.	58.2	19.2	364.2
37	9.5	3.1	61.0	0.8664	73.1	0.	6.	56.9	18.8	365.8
38	9.3	3.1	61.3	0.8700	73.1	0.	6.	55.6	18.3	367.5
39	9.0	3.0	61.5	0.8732	73.1	0.	6.	54.2	17.9	369.0
40	8.8	2.9	61.8	0.8761	73.1	0.	6.	53.0	17.5	370.5

MAXIMUM INJECTION RATE IS 1.201 MBBL/D

MAJOR CAPITAL COSTS

INJECTOR DRILLING COST	327062.	$/WELL
PRODUCER EQUIPMENT COST	128487.	$/WELL
COST TO UPGRADE SECONDARY PROD	0.	$/WELL
COST TO CONVERT PROD TO INJ	0.	$/WELL
COST TO UPGRADE TO SEC. OPERATIONS	0.	$/WELL
CAPACITY OF WATER INJ PLANT	0.4	MMB/YR
CAPITAL FOR WATER INJ PLANT	0.0	M$

PROJECT CAPITAL SCHEDULE - MOST LIKELY

	--- PATTERN $ ---		PATTERNS	--- PROJECT M$ ----	
YEAR	TANGIBLE	INTANGBL	INITIATD	TANGIBLE	INTANGBL
1	37775.0	783965.4	6.	227.	4704.
2	0.0	0.0	0.	0.	0.
3	0.0	0.0	0.	0.	0.
4	0.0	0.0	0.	0.	0.
5	0.0	0.0	0.	0.	0.
6	0.0	0.0	0.	0.	o.
7	0.0	0.0	0.	0.	0.
8	0.0	0.0	0.	0.	0,
9	0.0	0.0	O.	O.	O.
10	0.0	0.0	0.	0.	0.
11	0.0	0.0	O.	O.	0.
12	0.0	0.0	0.	0.	0.
13	0.0	0.0	0.	0.	0.
14	0.0	0.0	0.	0.	0.
15	0.0	0.0	0.	0.	0.
16	0.0	0.0	0.	0.	0.
17	0.0	0.0	0.	0.	0.
18	0.0	0.0	0.	0.	0.
19	0.0	0.0	0.	0.	0.
20	0.0	0.0	0.	0.	0.
21	0.0	0.0	0.	0.	0.
22	0.0	0.0	0.	0.	0.
23	0.0	0.0	0.	0.	0.
24	0.0	0.0	0.	0.	0.
25	0.0	0.0	0.	0.	0.
26	0.0	0.0	0.	0.	0.
27	0.0	0.0	0.	0.	0.
28	0.0	0.0	0.	0.	0.
29	0.0	0.0	0.	0.	0.
30	0.0	0.0	0.	0.	0.
31	0.0	0.0	0.	0.	0.
32	0.0	0.0	0.	0.	0.
33	0.0	0.0	0.	0.	0.
34	0.0	0.0	0.	0.	0.
35	0.0	0.0	0.	0.	0.
36	0.0	0.0	0.	0.	0.
37	0.0	0.0	0.	0.	0.
38	0.0	0.0	0.	0.	0.
39	0.0	0.0	0.	0.	O.
40	0.0	0.0	0.	0.	0.

PROJECT MEAN VALUES - ESCALATED

YEAR	OIL PRICE $/BBL	GAS PRICE $/MCF	TANGIBLE CAPITAL M$/YR	INTANGBL CAPITAL M$/YR	FIXED OPN COST M$/YR	VARIABLE OPN COST $/BBL	WELL WORKOVER M$/YR	WATER TREATING $/BBL
1	20.00	3.33	227.	4704.	250.	0.050	72.	0.030
2	20.00	3.33	0.	0.	250.	0.050	72.	0.030
3	20.00	3.33	0.	0.	250.	0.050	72.	0.030
4	20.00	3.33	0.	0.	250.	0.050	7?.	0.030
5	20.00	3.33	0.	0.	250.	0.050	72.	0.030

6	20.00	3.33	0.	0.	250.	0.050	72.	0.030
7	20.00	3.33	0.	O.	250.	0.050	72.	0.030
8	20.00	3.33	0.	0.	250.	0.050	72.	0.030
9	20.00	3.33	0.	0.	250.	0.050	72.	0.030
10	20.00	3.33	0.	0.	250.	0.050	72.	0.030
11	20.00	3.33	0.	0.	250.	0.050	72.	0.030
12	20.00	3.33	0.	0.	250.	0.050	72.	0.030
13	20.00	3.33	0.	0.	250.	0.050	72.	0.030
14	20.00	3.33	0.	0.	250.	0.050	72.	0.030
15	20.00	3.33	0.	0.	250.	0.050	72.	0.030
16	20.00	3.33	0.	0.	250.	0.050	72.	0.030
17	20.00	3.33	0.	0.	250.	0.050	72.	0.030
18	20.00	3.33	0.	0.	250.	0.050	12.	0.030
19	20.00	3.33	0.	0.	250.	0.050	72.	0.030
20	20.00	3.33	0.	0.	250.	0.050	72.	0.030
21	20.00	3.33	0.	0.	250.	0.050	72.	0.030
22	20.00	3.33	0.	0.	250.	0.050	72.	0.030
23	20.00	3.33	0.	0.	250.	0.050	72.	0.030
24	20.00	3.33	0.	0.	250.	0.050	72.	0.030
25	20.00	3.33	0.	0.	250.	0.050	72.	0.030
26	20.00	3.33	0.	0.	250.	0.050	72.	0.030
27	20.00	3.33	0.	0.	250.	0.050	72.	0.030
28	20.00	3.33	0.	0.	250.	0.050	72.	0.030
29	20.00	3.33	0.	0.	250.	0.050	72.	0.030
30	20.00	3.33	0.	0.	250.	0.050	72.	0.030
31	20.00	3.33	0.	0.	250.	0.050	72.	0.030
32	20.00	3.33	0.	0.	250.	0.050	72.	0.030
33	20.00	3.33	0.	0.	250.	0.050	72.	0.030
34	20.00	3.33	0.	0.	250.	0.050	72.	0.030
35	20.00	3.33	0.	0.	250.	0.050	72.	0.030
36	20.00	3.33	0.	0.	250.	0.050	72.	0.030
37	20.00	3.33	0.	0.	250	0.050	72.	0.030
38	20.00	3.33	0.	0.	250.	0.050	72.	0.030
39	20.00	3.33	0.	0.	250.	0.050	72.	0.030
40	20.00	3.33	0.	0.	250.	0.050	72.	0.030

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	1 1994.	2 1995.	3 1996.	4 1997.	5 1998.
ANNUAL OIL PRODUCTION, MSTB	347.51	341.50	339.23	305.66	273.87
ANNUAL GAS PRODUCTION, MMSCF	114.68	112.69	111.95	100.87	90.38
ANNUAL WATER PRODUCTION, MSTB	0.	0.	3.	46.	87.
OIL PRODUCTION RATE, STB/D	952.	936.	929.	837.	750.
GAS PRODUCTION RATE, MSCF/D	314.	309.	307.	276.	248.
WATER PRODUCTION RATE, STB/D	0.	0.	8.	126.	238.
NET OIL SOLD (LESS ROYALTY), MSTB	304.08	298.81	296.83	267.45	239.64
NET GAS SOLD (LESS ROYALTY), MMSCF	100.34	98.61	97.95	88.26	79.08
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	6.95	6.83	6.78	6.11	5.48
ANNUAL GROSS GAS SALES, MM$	0.38	0.38	0.37	0.34	0.30
ANNUAL TOTAL GROSS SALES, MM$	7.33	7.21	7.16	6.45	5.78
ANNUAL ROYALTY, MM$	0.92	0.90	0.89	0.81	0.72
ANNUAL NET SALES, MM$	6.42	6.30	6.26	5.64	5.06
ANNUAL SEVERANCE TAX, MM$	0.51	0.50	0.50	0.45	0.40
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.02	0.02	0.02	0.02	0.01
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL PROD WATER TREATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL OVERHEAD, MM$	0.31	0.07	0.07	0.07	0.07
ANNUAL TOTAL OPERATING COST, MM$	1.17	0.91	0.91	0.86	0.81
ANNUAL NET OPERATING INCOME, MM$	5.25	5.39	5.35	4.79	4.25
CUM NET OPERATING INCOME, MM$	5.25	10.64	16.00	20.78	25.03
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.23	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	4.70	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	0.32	5.71	11.07	15.85	20.10
BASE PRICE OF OIL FOR WPT, $/BBL	23.07	24.68	26.41	28.26	30.24
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.21	0.22	0.21	0.19	0.17
ANNUAL INTANGIBLES AND DEPR, MM$	4.75	0.05	0.05	0.05	0.05
ANNUAL INVESTMENT TAX CREDIT, MM$	0.02	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	0.29	5.13	5.10	4.55	4.03
ANNUAL FEDERAL INCOME TAX, MM$	0.11	2.36	2.34	2.09	1.85
ANNUAL AFTER TAX CASH FLOW, MM$	0.00	2.82	2.80	2.50	2.22
CUM CASH FLOW AFTER TAXES, MM$	0.00	2.81	5.61	8.11	10.33

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	6 1999.	7 2000.	8 2001.	9 2002.	10 2003.
ANNUAL OIL PRODUCTION, MSTB	247.22	218.78	196.17	178.85	163.75
ANNUAL GAS PRODUCTION, MMSCF	81.58	72.20	64.73	59.02	54.04
ANNUAL WATER PRODUCTION, MSTB	121.	158.	187.	209.	229.
OIL PRODUCTION RATE, STB/D	677.	599.	537.	490.	449.
GAS PRODUCTION RATE, MSCF/D	224.	198.	177.	162.	148.
WATER PRODUCTION RATE, STB/D	331.	432.	512.	573.	626.
NET OIL SOLD (LESS ROYALTY), MSTB	216.32	191.43	171.65	156.49	143.28
NET GAS SOLD (LESS ROYALTY), MMSCF	71.38	63.17	56.64	51.64	47.28
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	4.94	4.38	3.92	3.58	3.27
ANNUAL GROSS GAS SALES, MM$	0.27	0.24	0.22	0.20	0.18
ANNUAL TOTAL GROSS SALES, MM$	5.22	4.62	4.14	3.77	3.45
ANNUAL ROYALTY, MM$	0.65	0.58	0.52	0.47	0.43
ANNUAL NET SALES, MM$	4.56	4.04	3.62	3.30	3.02
ANNUAL SEVERANCE TAX, MM$	0.37	0.32	0.29	0.26	0.24
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM,	0.01	0.01	0.01	0.01	0.01
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0 07	0 07	0 07
ANNUAL PROD WATER TREATING COST, MM$	0.00	0.00	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL TOTAL OPERATING COST, MM$	0.77	0.73	0.69	0.67	0.65
ANNUAL NET OPERATING INCOME, MM$	3.79	3.31	2.93	2.63	2.38
CUM NET OPERATING INCOME, MM$	28.82	32.13	35.06	37.69	40.07
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	23.89	27.20	30.13	32.76	35.14
BASE PRICE OF OIL FOR WPT, $/BBL	32.36	34.62	37.05	39.64	42.41
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0 00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0 00
ANNUAL STATE INCOME TAX, MM$	0.15	0.13	0.12	0.11	0.10
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	3.64	3.18	2.81	2.53	2.28
ANNUAL FEDERAL INCOME TAX, MM$	1.68	1.46	1.29	1.16	1.05
ANNUAL AFTER TAX CASH FLOW, MM$	1.97	1.72	1.52	1.37	1.23
ANNUAL CASH FLOW AFTER TAXES, MM$	12.30	14.02	15.53	16.90	18.13

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	11 2004.	12 2005.	13 2006.	14 2007.	15 2008.
ANNUAL OIL PRODUCTION, MSTB	151.40	140.83	132.04	124.02	117.15
ANNUAL GAS PRODUCTION, MMSCF	49.96	46.47	43.57	40.93	38.66
ANNUAL WATER PRODUCTION, MSTB	245.	258.	269.	279.	288.
OIL PRODUCTION RATE, STB/D	415.	386.	362.	340.	321.
GAS PRODUCTION RATE, MSCF/D	137.	127.	119.	112.	106.
WATER PRODUCTION RATE, STB/D	670.	707.	738.	766.	790.
NET OIL SOLD (LESS ROYALTY), MSTB	132.48	123.22	115.53	108.52	102.51
NET GAS SOLD (LESS ROYALTY), MMSCF	43.72	40.66	38.13	35.81	33.83
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	3.03	2.82	2.64	2.48	2.34
ANNUAL GROSS GAS SALES, MM$	0.17	0.15	0.15	0.14	0.13
ANNUAL TOTAL GROSS SALES, MM$	3.19	2.97	2.79	2.62	2.47
ANNUAL ROYALTY, MM$	0.40	0.37	0.35	0,33	0.31
ANNUAL NET SALES, MM$	2.80	2.60	2.44	2.29	2.16
ANNUAL SEVERANCE TAX, MM$	0.22	0.21	0.20	0.18	0.17
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL PROD WATER TREATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL TOTAL OPERATING COST, MM$	0.63	0.61	0.60	0.59	0.58
ANNUAL NET OPERATING INCOME, MM$	2.17	1.99	1.84	1.70	1.59
CUM NET OPERATING INCOME, MM$	42.24	44.22	46.06	47.77	49.35
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	37.31	39.29	41.13	42.84	44.42
BASE PRICE OF OIL FOR WPT, $/BBL	45.38	48.56	51.96	55.60	59.49
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.09	0.08	0.07	0.07	0.06
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	2.08	1.91	1.77	1.63	1.52
ANNUAL FEDERAL INCOME TAX, MM$	0.96	0.88	0.81	0.75	0.70
ANNUAL AFTER TAX CASH FLOW, MM$	1.12	1.03	0.95	0.88	0.82
CUM CASH FLOW AFTER TAXES, MM$	19.26	20.29	21.24	22.12	22.94

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	16 2009.	17 2010.	18 2011.	19 2012.	20 2013.
ANNUAL OIL PRODUCTION, MSTB	111.18	105.98	101.42	97.25	93.40
ANNUAL GAS PRODUCTION, MMSCF	36.69	34.97	33.47	32.09	30.82
ANNUAL WATER PRODUCTION, MSTB	296.	303.	309.	314.	319.
OIL PRODUCTION RATE, STB/D	305.	290.	278.	266.	256.
GAS PRODUCTION RATE, MSCF/D	101.	96.	92.	88.	04.
WATER PRODUCTION RATE, STB/D	811.	829.	846.	860.	873.
NET OIL SOLD (LESS ROYALTY), MSTB	97.28	92.74	88.74	85.09	81.73
NET GAS SOLD (LESS ROYALTY), MMSCF	32.10	30.60	29.28	28.08	26.97
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	2.22	2.12	2.03	1.94	1.87
ANNUAL GROSS GAS SALES, MM$	0.12	0.12	0.11	0.11	0.10
ANNUAL TOTAL GROSS SALES, MM$	2.35	2.24	2.14	2.05	1.97
ANNUAL ROYALTY, MM$	0.29	0.28	0.27	0.26	0.25
ANNUAL NET SALES, MM$	2.05	1.96	1.87	1.80	1.72
ANNUAL SEVERANCE TAX, MM$	0.16	0.16	0.15	0.14	0.14
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.01	0.01	0.01	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL PROD WATER TREATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.07	0.07	0.07	0 07	0 07
ANNUAL TOTAL OPERATING COST, MM$	0.57	0.56	0.55	0.55	0 54
ANNUAL NET OPERATING INCOME, MM$	1.48	1.40	1.32	1.25	1.18
CUM NET OPERATING INCOME, MM$	50.84	52.23	53.55	54.80	55.98
ANNUAL WORKING CAPITAL, MM$	0.00	0 00	0 00	0 00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0 00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	45.91	47.30	48.62	49.87	51.05
BASE PRICE OF OIL FOR WPT, $/BBL	63.65	68.11	72.87	77.98	83.43
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0 00	0 00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.06	0.06	0.05	0.05	0.05
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0 00	0 00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0 00	0 00
ANNUAL NET TAXABLE INCOME, MM$	1.43	1.34	1.27	1.20	1.14
ANNUAL FEDERAL INCOME TAX, MM$	0.66	0.62	0.58	0.55	0.52
ANNUAL AFTER TAX CASH FLOW, MM$	0.77	0.72	0.68	0.65	0.61
CUM CASH FLOW AFTER TAXES, MM$	23.71	24.44	25.12	25.77	26.38

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	21 2014.	22 2015.	23 2016.	24 2017.	25 2018.
ANNUAL OIL PRODUCTION, MSTB	89.89	86.81	83.82	81.03	78.40
ANNUAL GAS PRODUCTION, MMSCF	29.66	28.65	27.66	26.94	25.8 7
ANNUAL WATER PRODUCTION, MSTB	323.	327.	331.	335.	338.
OIL PRODUCTION RATE, STB/D	246.	238.	230.	222.	215.
GAS PRODUCTION RATE, MSCF/D	81.	78.	76.	73.	71.
WATER PRODUCTION RATE, STB/D	886.	897.	907.	916.	926.
NET OIL SOLD (LESS ROYALTY), MSTB	78.65	75.96	73.34	70.90	68.60
NET GAS SOLD (LESS ROYALTY), MMSCF	25.96	25.07	24.20	23.40	22.64
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	1.80	1.74	1.68	1.62	1.57
ANNUAL GROSS GAS SALES, MM$	0.10	0.10	0.09	0.09	0.09
ANNUAL TOTAL GROSS SALES, MM$	1.90	1.83	1.77	1.71	1.65
ANNUAL ROYALTY, MM$	0.24	0.23	0.22	0.21	0.21
ANNUAL. NET SALES, MM$	1.66	1.60	1.55	1.50	1.45
ANNUAL SEVERANCE TAX, MM$	0.13	0.13	0.12	0.12	0.12
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0.07	0,07	0.07
ANNUAL PROD WATER TREATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL TOTAL OPERATING COST, MM$	0.54	0.53	0.53	0.52	0.52
ANNUAL NET OPERATING INCOME, MM$	1.12	1.07	1.02	0.97	0.93
ANNUAL CUM NET OPERATING INCOME, MM$	57.11	58.18	59.20	60.17	61.10
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	52.18	53.25	54.27	55.24	56.17
BASE PRICE OF OIL FOR WPT, $/BBL	89.27	95.52	102.21	109.36	117.02
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.04	0.04	0.04	0.04	0.04
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	1.08	1.03	0.98	0.93	0.89
ANNUAL FEDERAL INCOME TAX, MM$	0.50	0.47	0.45	0.43	0.41
ANNUAL AFTER TAX CASH FLOW, MM$	0.58	0.56	0.53	0.50	0.48
CUM CASH FLOW AFTER TAXES, MM$	26.96	27.52	28.05	28.55	29.03

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

	26	27	28	29	30
YEAR ENDING	2019.	2020.	2021.	2022.	2023.
ANNUAL OIL PRODUCTION, MSTB	75.96	73.75	71.53	69.59	67.68
ANNUAL GAS PRODUCTION, MMSCF	25.07	24.34	23.61	22.96	22.33
ANNUAL WATER PRODUCTION, MSTB	341.	344.	346.	349.	352.
OIL PRODUCTION RATE, STB/D	208.	202.	196.	191.	185.
GAS PRODUCTION RATE, MSCF/D	69.	67.	65.	63.	61.
WATER PRODUCTION RATE, STB/D	934.	942.	949.	957.	963.
NET OIL SOLD (LESS ROYALTY), MSTB	66.47	64.53	62.59	60.89	59.22
NET GAS SOLD (LESS ROYALTY), MMSCF	21.93	21.30	20.66	20.09	19.54
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	1.52	1.47	1.43	1.39	1.35
ANNUAL GROSS GAS SALES, MM$	0.08	0.08	0.08	0.08	0.07
ANNUAL TOTAL GROSS SALES, MM$	1.60	1.56	1.51	1.47	1.43
ANNUAL ROYALTY, MM$	0.20	0.19	0.19	0.18	0.18
ANNUAL. NET SALES, MM$	1.40	1.36	1.32	1.28	1.25
ANNUAL SEVERANCE TAX, MM$	0.11	0.11	0.11	0.10	0.10
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL PROD WATER TREATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL TOTAL OPERATING COST, MM$	0.52	0.51	0.51	0.51	0.50
ANNUAL NET OPERATING INCOME, MM$	0.89	0.85	0.81	0.78	0.75
ANNUAL CUM NET OPERATING INCOME, MM$	61.99	62.84	63.65	64.43	65.17
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0 00	0 00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	57.06	57.91	58.72	59.50	60.24
BASE PRICE OF OIL FOR WPT, $/BBL	125.21	133.98	143.35	153.39	164.13
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.04	0.03	0.03	0.03	0.03
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	0.85	0.82	0.78	0.75	0.72
ANNUAL FEDERAL INCOME TAX, MM$	0.39	0.38	0.36	0.34	0.33
ANNUAL AFTER TAX CASH FLOW, MM$	0.46	0.44	0.42	0.40	0.39
CUM CASH FLOW AFTER TAXES, MM$	29.49	29.93	30.36	30.76	31.15

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	31 2024.	32 2025.	33 2026.	34 2027.	35 2028.
ANNUAL OIL PRODUCTION, MSTB	65.90	64.22	62.57	61.04	59.70
ANNUAL GAS PRODUCTION, MMSCF	21.75	21.19	20.65	20.14	19.70
ANNUAL WATER PRODUCTION, MSTB	354.	356.	358.	360.	362.
OIL PRODUCTION RTE, STB/D	181.	176.	171.	167.	164.
GAS PRODUCTION RATE, MSCF/D	60.	58.	57.	55.	54.
WATER PRODUCTION RATE, STB/D	970.	976.	982.	987.	993
NET OIL SOLD (LESS ROYALTY), MSTB	57.67	56.19	54.75	53.41	52.24
NET GAS SOLD (LESS ROYALTY), MMSCF	19.03	18.54	18.07	17.62	17.24
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	1.32	1.28	1.25	1.22	1.19
ANNUAL GROSS GAS SALES, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL TOTAL GROSS SALES, MM$	1.39	1.35	1.32	1.29	1.26
ANNUAL ROYALTY, MM$	0.17	0.17	0.17	0.16	0.16
ANNUAL NET SALES, MM$	1.22	1.19	1.16	1.13	1.10
ANNUAL SEVERANCE TAX, MM$	0.10	0.09	0.09	0.09	0.09
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL PROD WATER TREATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL TOTAL OPERATING COST, MM$	0.50	0.50	0.50	0.49	0.49
ANNUAL NET OPERATING INCOME, MM$	0.72	0.69	0.66	0.63	0.61
CUM NET OPERATING INCOME, MM$	65.89	66.58	67.24	67.87	68.48
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0 00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	60.96	61.65	62.31	62.94	63.55
BASE PRICE OF OIL EOR WPT, $/BBL	175.61	187.91	201.06	215.14	230.20
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.03	0.03	0.03	0.03	0.02
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	0.69	0.66	0.63	0.61	0.59
ANNUAL FEDERAL INCOME TAX, MM$	0.32	0.30	0.29	0.28	0.27
ANNUAL AFTER TAX CASH FLOW, MM$	0.37	0.36	0.34	0.33	0.32
CUM CASH FLOW AFTER TAXES, MM$	31.52	31.87	32.22	32.54	32.86

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	36 2029.	37 2030.	38 2031.	39 2032.	40 2033.
ANNUAL OIL PRODUCTION, MSTB	58.25	56.93	55.56	54.21	53.01
ANNUAL GAS PRODUCTION, MMSCF	19.22	18.79	18.33	17.89	17.49
ANNUAL WATER PRODUCTION, MSTB	364.	366.	368.	369.	371.
OIL PRODUCTION RTE, STB/D	160.	156.	152.	149.	145.
GAS PRODUCTION RATE, MSCF/D	53.	51.	50.	49.	48.
WATER PRODUCTION RATE, STB/D	998.	1002.	1007.	1011.	1015.
NET OIL SOLD (LESS ROYALTY), MSTB	50.97	49.81	48.61	47.43	46.39
NET GAS SOLD (LESS ROYALTY), MMSCF	16.82	16.44	16.04	15.65	15.31
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	1.16	1.14	1.11	1.08	1.06
ANNUAL GROSS GAS SALES, MM$	0.06	0.06	0.06	0.06	0.06
ANNUAL TOTAL GROSS SALES, MM$	1.23	1.20	1.17	1.14	1.12
ANNUAL ROYALTY, MM$	0.15	0.15	0.15	0.14	0.14
ANNUAL NET SALES, MM$	1.08	1.05	1.03	1.00	0.98
ANNUAL SEVERANCE TAX, MM$	0.09	0.08	0.08	0.08	0.08
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL PROD WATER TREATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL TOTAL OPERATING COST, MM$	0.49	0.49	0.48	0.48	0.48
ANNUAL NET OPERATING INCOME, MM$	0.59	0.56	0.54	0.52	0.50
CUM NET OPERATING INCOME, MM$	69.07	69.63	70.17	70.69	71.19
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0 00	0 00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0 00	0 00
CUM CASH FLOW BEFORE TAXES, MM$	64.14	64.70	65.24	65.76	66.26
BASE PRICE OF OIL EOR WPT, $/BBL	246.31	263.55	282.00	301.74	322.86
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.02	0.02	0.02	0.02	0.02
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	0.56	0.54	0.52	0.50	0.48
ANNUAL FEDERAL INCOME TAX, MM$	0.26	0.25	0.24	0.23	0.22
ANNUAL AFTER TAX CASH FLOW, MM$	0.30	0.29	0.28	0.27	0.26
CUM CASH FLOW AFTER TAXES, MM$	33.17	33.46	33.74	34.01	34.26

UNDISCOUNTED MEAN RESULTS

PROJECT ECONOMIC LIFE	40.0	YEARS
TOTAL GROSS SALES	108.808	MM$
TOTAL NET SALES	95.207	MM$
TOTAL SEVERANCE TAX	7.617	MM$
TOTAL FIXED OPERATING COST	9.994	MM$
TOTAL VARIABLE OPERATING COST	0.258	MM$
TOTAL WELL WORKOVER COST	2.883	MM$
TOTAL PROD WATER TREATING COST	0.328	MM$
TOTAL OVERHEAD	2.939	MM$
TOTAL OPERATING COS T	24.019	MM$
TOTAL WORKING CAPITAL	0.000	MM$
TOTAL TANGIBLE CAPITAL	0.227	MM$
TOTAL INTANGIBLE CAPITAL	4.704	MM$
TOTAL CAPITAL INVESTMENT	4.930	MM$
TOTAL DEBT INTEREST EXPENSE	0.000	MM$
TOTAL PROJECT EXPENSE	28.949	MM$

TOTAL CASH FLOW BEFORE TAX	66.258	MM$
TOTAL WINDFALL PROFITS TAX	0.000	MM$
TOTAL STATE INCOME TAX	2.848	MM$
TOTAL FEDERAL INCOME TAX	29.146	MM$
TOTAL AFTER TAX CASH FLOW	34.264	MM$
TOTAL LOAN AMOUNT	0.000	MM$

PROJECT ECONOMIC ANALYSIS

		PRESNT VALUE	MEAN VALUE CASH FLOW					
			BEFORE TAX (MM$)			AFTER TAX (MM$)		
	YEAR	FACTOR	ANNUAL	CONST $	DISCNTD	ANNUAL	CONST $	DISCNTD
1	1994.	1.0000	0.32	0.32	0.32	0.00	0.00	0.00
2	1995.	0.8658	5.71	5.45	4.99	2.81	2.68	2.44
3	1996.	0.7496	11.07	10.31	9.00	5.61	5.22	4.53
4	1997.	0.6490	15.85	14.45	12.11	8.11	7.38	6.16
5	1998.	0.5619	20.10	17.94	14.49	10.33	9.21	7.41
6	1999.	0.4865	23.89	20.91	16.34	12.30	10.75	8.36
7	2000.	0.4212	27.20	23.38	17.73	14.02	12.03	9.08
8	2001.	0.3647	30.13	25.46	18.80	15.53	13.11	9.64
9	2002.	0.3158	32.76	27.24	19.63	16.90	14.03	10.07
10	2003.	0.2734	35.14	28.78	20.28	18.13	14.82	10.41
11	2004.	0.2367	37.31	30.11	20.80	19.26	15.51	10.67
12	2005.	0.2049	39.29	31.27	21.20	20.29	16.12	10.88
13	2006.	0.1774	41.13	32.29	21.53	21.24	16.65	11.05
14	2007.	0.1536	42.84	33.20	21.79	22.12	17.12	11.19
15	2008.	0.1330	44.42	34.00	22.00	22.94	17.53	11.30
16	2009.	0.1152	45.91	34.71	22.17	23.71	17.90	11.39
17	2010.	0.0997	47.30	35.35	22.31	24.44	18.23	11.46
18	2011.	0.0863	48.62	35.93	22.43	25.12	18.53	11.52
19	2012.	0.0747	49.87	36.44	22.52	25.77	18.80	11.57
20	2013.	0.0647	51.05	36.91	22.60	26.38	19.04	11.60
21	2014.	0.0560	52.18	37.34	22.66	26.96	19.26	11.64
22	2015.	0.0485	53.25	37.72	22.71	27.52	19.46	11.66
23	2016.	0.0420	54.27	38.07	22.75	28.05	19.64	11.69
24	2017.	0.0364	55.24	38.39	22.79	28.55	19.81	11.71
25	2018.	0.0315	56.17	38.67	22.82	29.03	19.96	11.72
26	2019.	0.0273	57.06	38.94	22.84	29.49	20.09	11.73
27	2020.	0.0236	57.91	39.17	22.86	29.93	20.21	11.74
28	2021.	0.0204	58.72	39.39	22.88	30.36	20.33	11.75
29	2022.	0.0177	59.50	39.59	22.89	30.76	20.43	11.76
30	2023.	0.0153	60.24	39.77	22.90	31.15	20.52	11.76
31	2024.	0.0133	60.96	39.94	22.91	31.52	20.61	11.77
32	2025.	0.0115	61.65	40.09	22.92	31.87	20.69	11.77
33	2026.	0.0099	62.31	40.23	22.93	32.22	20.76	11.78
34	2027.	0.0086	62.94	40.35	22.93	32.54	20.83	11.78
35	2028.	0.0075	63.55	40.47	22.94	32.86	20.89	11.78
36	2029.	0.0065	64.14	40.58	22.94	33.17	20.94	11.78
37	2030.	0.0056	64.70	40.67	22.94	33.46	20.99	11.79
38	2031.	0.0048	65.24	40.76	22.95	33.74	21.04	11.79
39	2032.	0.0042	65.76	40.84	22.95	34.01	21.08	11.79
40	2033.	0.0036	66.26	40.92	22.95	34.26	21.12	11.79

S C I E N T I F I C S O F T W A R E
I N T E R C O M P

INFILL DRILLING PREDICTION MODEL
(IDPM -- RELEASE 1.2.0)

ECONOMICS FOR WATERFLOOD

PRODUCTION SUMMARY

PROJECT ECONOMIC LIFE 40.0 YEARS

CUMULATIVE GROSS OIL SOLD	5157.	MSTB
CUMULATIVE GROSS GAS SOLD	1702.	MMSCF
CUMULATIVE NET OIL SOLD	4512.	MSTB
PRESENT VALUE OF NET OIL SOLD	1604.	MSTB

MEAN RESULTS

PRESENT VALUE OF TOTAL GROSS SALES	38.684	MM$
PRESENT VALUE OF TOTAL NET SALES	33.848	MM$
TOTAL SEVERANCE TAX (PV)	2.708	MM$
TOTAL FIXED OPERATING COST (PV)	1.856	MM$
TOTAL VARIABLE OPERATING COST (PV)	0.092	MM$
TOTAL WELL WORKOVER COST (PV)	0.535	MM$
TOTAL PROD WATER TREATING COST (PV)	0.027	MM$
TOTAL OVERHEAD (PV)	0.749	MM$
TOTAL OPERATING COST (PV)	5.967	MM$
TOTAL WORKING CAPITAL (PV)	0.000	MM$
TOTAL TANGIBLE CAPITAL INVESTED (PV)	0.227	MM$
TOTAL INTANGIBLE CAPITAL (PV)	4.704	MM$
TOTAL CAPITAL INVESTMENT (PV)	4.930	MM$
TOTAL INTEREST EXPENSE (PV)	0.000	MM$
TOTAL PROJECT EXPENSE (PV)	10.897	MM$
TOTAL LOAN PRINCIPAL REPAYMENT (PV)	0.000	MM$
DISCOUNTED COST PER DISC NET OIL	6.793	$/BBL
DISCOUNTED CASH FLOW BEFO RE TAX	22.951	MM$

PROJECT PROFITABILITY (AFTER TAX)

AVERAGE MONETARY DISCOUNT RATE	10.00	PCNT
90 PCNT CONFIDENCE DCF	6.773	MM$
MEAN DISCOUNTED CASH FLOW	11.789	MM$
10 PCNT CONFIDENCE DCF	17.670	MM$
STANDARD DEVIATION OF THE MEAN DCF	4.112	MM$
MEAN DCF PROFIT TO INVESTMENT RATIO	2.391	P/I
MEAN DCF PROFIT TO EXPENSE RATIO	1.082	P/E
MEAN DCF PROFIT PER DISC NET OIL	7.349	$/BBL
MEAN INVESTMENT EFFICIENCY	3.908	
MEAN DCF RATE OF RETURN	100.00	PCNT

S C I E N T I F I C   S O F T W A R E
I N T E R C O M P

INFILL DRILLING PREDICTION MODEL
(IDPM -- RELEASE 1.2.0)

ECONOMICS FOR INFILL WATERFLOOD

ECONOMIC DATA

NUMBER OF PROJECT YEARS	40	
STATE CODE	NONE	
DISTRICT CODE	0	
PRINT CONTROL	2	IOUT
FEDERAL INCOME TAX OPTION	0	IFIT
DISCOUNTING METHOD	0	IDISC
DEPRECIATION METHOD	0	IDEP
PROJECT ECONOMIC LIFE METHOD	O	IPLIF
RESERVOIR DEPTH	6300.0	FEET
INJECTORS DRILLED PER PATTERN (WPP1)	0.00	
PRODUCERS DRILLED PER PATTERN (WPP2)	2.00	
CONVTD PRIMARY PROD PER PAT (WPP3)	0.00	
CONVTD PROD TO INJ PER PAT (WPP4)	1.00	
NO. OF MONTHS WORKING CAPITAL	0.00	
PROJECT STARTUP COSTS	0.0	M$
OIL RATE UNCERTAINTY	0.0010	FRACTION
PERCENT OF CAPITAL BORROWED	0	PERCENT

TAXES AND ESCALATION

DISCOUNT RATE	0.100	FRACTION
INFLATION RATE	0.050	FRACTION
ROYALTY RATE	0.125	FRACTION
SEVERANCE TAX RATE	0.080	FRACTION
FEDERAL INCOME TAX RATE	0.460	FRACTION
INVESTMENT TAX CREDIT	0.100	FRACTION
DEPRECIATION TIME (STRAIGHT LINE)	5.00	YEARS
STATE INCOME TAX RATE	0.040	FRACTION
WINDFALL EXCISE TAX RATE	0.000	FRACTION
WINDFALL PHASE OUT START DATE	1991.	
WINDFALL PHASE OUT END DATE	1993.	
PROJECT START DATE	1994.	
BASE OIL PRICE FOR WINDFALL TAX	23.07	$/BBL
OIL PRICE ESCALATION RATE	0.000	FRACTION
GAS PRICE ESCALATION RATE	0.000	FRACTION
OPERATING COST ESCALATION RATE	0.000	FRACTION

PRICES AND COSTS		LOW	MOST-LIKELY	HIGH
OIL PRICE	S/BBL	16.00	20.00	24.00
GAS PRICE	$/MCF	2.67	3.33	4.00
FIXED OPERATING COST PER PATTERN	$/YR	33313.	41642.	49970.
VARIABLE OPERATING COST	$/BBL	0.040	0.050	0.060
WELL WORKOVER COST PER PATTERN	$/YR		12013.	
PROD WATER TREATING/DISPOSAL COST	$/BBL		0.030	

NOTE: -PATTERN- HERE ALWAYS REFERS TO THE PRE-INFILL FULL 5-SPOT PATTERN

ANNUAL PATTERN AND PROJECT VOLUMES PRODUCED

PROJECT LIFE IS 40 YEARS
PROJECT INITIATED AT 17.50 YEARS OF NON-INFILL PROJECT

	--------------PATTERN-------------					------------------PROJECT------------- -				
	INJ									
	OIL,	GAS,	WATER,	YR-END	WTR,	PATTERNS	PATTERNS	OIL,	GAS,	WATER,
YR	MSTB	MMSCF	MSTB	WTR-CUT	MSTB	INITIATD	TOTAL	MSTB	MMSCF	MSTB
1	44.0	14.5	89.8	0.6719	146.1	6.	6.	264.3	87.2	538.8
2	40.9	13.5	93.7	0.7218	146.1	0.	6.	245.6	81.1	562.2
3	35.2	11.6	101.0	0.7552	146.1	0.	6.	211.4	69.8	606.1
4	31.7	10.5	105.6	0.7797	146.1	0.	6.	190.1	62.1	633.3
5	29.0	9.6	109.0	0.7981	146.1	0.	6.	173.8	57.4	654.2
6	26.8	8.9	111.7	0.8128	146.1	0.	6.	161.0	53.1	670.5
7	25.1	8.3	113.9	0.8243	146.1	0.	6.	150.8	49.8	683.5
8	23.7	7.8	115.7	0.8340	146.1	0.	6.	142.4	47.0	694.3
9	22.6	7.4	117.2	0.8420	146.1	0.	6.	135.3	44.7	703.3
10	21.5	7.1	118.5	0.8494	146.1	0.	6.	129.2	42.6	711.0
11	20.6	6.8	119.7	0.8556	146.1	0.	6.	123.9	40.9	718.0
12	19.9	6.6	120.7	0.8612	146.1	0.	6.	119.1	39.3	724.1
13	19.1	6.3	121.6	0.8662	146.1	0.	6.	114.9	37.9	729.7
14	18.5	6.1	122.5	0.8712	146.1	0.	6.	110.8	36.6	734.8
15	17.9	5.9	123.2	0.8755	146.1	0.	6.	107.2	35.4	739.5
16	17.3	5.7	124.0	0.8794	146.1	0.	6.	103.7	34.2	743.8
17	16.8	5.5	124.6	0.8831	146.1	0.	6.	100.6	33.2	747.9
18	16.3	5.4	125.3	0.8866	146.1	0.	6.	97.6	32.2	751.7
19	15.8	5.2	125.9	0.8900	146.1	0.	6.	94.8	31.3	755.2
20	15.4	5.1	126.4	0.8930	146.1	0.	6.	92.2	30.4	758.5
21	15.0	4.9	127.0	0.8959	146.1	0.	6.	89.7	29.6	761.8
22	14.6	4.8	127.5	0.8987	146.1	0.	6.	87.4	28.8	764.8
23	14.2	4.7	128.0	0.9014	146.1	0.	6.	85.1	28.1	767.7
24	13.8	4.6	128.4	0.9038	146.1	0.	6.	83.1	27.4	770.4
25	13.5	4.5	128.8	0.9063	146.1	0.	6.	81.0	26.7	772.9
26	13.2	4.3	129.2	0.9085	146.1	0.	6.	79.0	26.1	775.4
27	12.9	4.2	129.7	0.9106	146.1	0.	6.	77.2	25.5	778.0
28	12.6	4.1	130.1	0.9129	146.1	0.	6.	75.3	24.9	780.3
29	12.3	4.1	130.4	0.9148	146.1	0.	6.	73.7	24.3	782.6
30	12.0	4.0	130.8	0.9168	146.1	0.	6.	72.0	23.8	784.7
31	11.7	3.9	131.1	0.9189	146.1	0.	6.	70.3	23.2	786.8
32	11.4	3.8	131.5	0.9207	146.1	0.	6.	68.7	22.7	788.9
33	11.2	3.7	131.8	0.9225	146.1	0.	6.	67.1	22.1	791.0
34	10.9	3.6	132.1	0.9244	146.1	0.	6.	65.6	21.7	792.9
35	10.7	3.5	132.5	0.9257	146.1	0.	6.	64.2	21.2	794.8
36	10.5	3.5	132.8	0.9276	146.l	0.	6.	62.8	20.7	796.6
37	10.2	3.4	133.0	0.9291	146.1	0.	6.	61.4	20.3	798.3
38	10.0	3.3	133.3	0.9307	146.1	0.	6.	60.2	19.9	799.9
39	9.8	3.2	133.6	0.9320	146.1	0.	6.	59.0	19.5	801.5
40	9.6	3.2	133.8	0.9335	146.1	0.	6.	57.8	19.1	803.0

MAXIMUM INJECTION RATE IS 2.402 MBBL/D

MAJOR CAPITAL COSTS

INJECTOR DRILLING COST	0.	$/WELL
PRODUCER EQUIPMENT COST	128487.	$/WELL
COST TO UPGRADE SECONDARY PROD	0.	$/WELL
COST TO CONVERT PROD TO INJ	48050.	S/WELL
COST TO UPGRADE TO SEC. OPERATIONS	30297.	$/WELL
CAPACITY OF WATER INJ PLANT	0.9	MMB/YR
CAPITAL EOR WATER INJ PLANT	0.0 M$	

PROJECT CAPITAL SCHEDULE -- MOST LIKELY

YEAR	--- PATTERN $ -- TANGIBLE	INTANGBL	PATTERNS INITIATD	--- PROJECT M$ -- TANGIBLE	INTANGBL
1	75550.1	963365.7	6.	453.	5780.
2	0.0	0.0	0.	0.	0.
3	0.0	0.0	0.	0.	0.
4	0.0	0.0	0.	0.	0.
5	0.0	0.0	0.	0.	o.
6	0.0	0.0	0.	0.	0.
7	0.0	0.0	0.	0.	0.
8	0.0	0.0	0.	0.	0.
9	0.0	0.0	O.	O.	O.
10	0.0	0.0	0.	0.	0.
11	0.0	0.0	o.	o.	o.
12	0.0	0.0	0.	0.	0.
13	0.0	0.0	0.	0.	0.
14	0.0	0.0	0.	0.	0.
15	0.0	0.0	0.	0.	0.
16	0.0	0.0	0.	0.	0.
17	0.0	0.0	0.	0.	0.
18	0.0	0.0	0.	0.	0.
19	0.0	0.0	0.	0.	0.
20	0.0	0.0	0.	0.	0.
21	0.0	0.0	0.	0.	0.
22	0.0	0.0	0.	0.	0.
23	0.0	0.0	0.	0.	0.
24	0.0	0.0	0.	0.	0.
25	0.0	0.0	0.	0.	0.
26	0.0	0.0	0.	0.	0.
27	0.0	0.0	0.	0.	0.
28	0.0	0.0	0.	0.	0.
29	0.0	0.0	0.	0.	0.
30	0.0	0.0	0.	0.	0.
31	0.0	0.0	0.	0.	0.
32	0.0	0.0	0.	0.	0.
33	0.0	0.0	0.	0.	0.
34	0.0	0.0	0.	0.	0.
35	0.0	0.0	0.	0.	0.
36	0.0	0.0	0.	0.	0.
37	0.0	0.0	0.	0.	0.
38	0.0	0.0	0.	0.	0.
39	0.0	0.0	0.	0.	0.
40	0.0	0.0	0.	0.	0.

PROJECT MEAN VALUES - ESCALATED

YEAR	OIL PRICE $/BBL	GAS PRICE $/MCF	TANGIBLE CAPITAL M$/YR	INTANGBL CAPITAL M$/YR	FIXED OPN COST M$/YR	VARIABLE OPN COST $/BBL	WELL WORKOVER M$/YR	WATER TREATING $/BBL
1	20.00	3.33	453.	5780.	250.	0.050	72.	0.030
2	20.00	3.33	0.	0.	250.	0.050	72.	0.030
3	20.00	3.33	0.	0.	250.	0.050	72.	0.030
4	20.00	3.33	0.	0.	250.	0.050	72.	0.030
5	20.00	3.33	0.	0.	250.	0.050	72.	0.030
6	20.00	3.33	0.	0.	250.	0.050	72.	0.030
7	20.00	3.33	0.	0.	250.	0.050	72.	0.030
8	20.00	3.33	0.	0.	250.	0.050	72.	0.030
9	20.00	3.33	0.	0.	250.	0.050	72.	0.030
10	20.00	3.33	0.	0.	250.	0.050	72.	0.030
11	20.00	3.33	0.	0.	250.	0.050	72.	0.030
12	20.00	3.33	0.	0.	250.	0.050	72.	0.030
13	20.00	3.33	0.	0.	250.	0.050	72.	0.030
14	20.00	3.33	0.	0.	250.	0.050	72.	0.030
15	20.00	3.33	0.	0.	250.	0.050	72.	0.030
16	20.00	3.33	0.	0.	250.	0.050	72.	0.030
17	20.00	3.33	0.	0.	250.	0.050	72.	0.030
18	20.00	3.33	0.	0.	250.	0.050	72.	0.030
19	20.00	3.33	0.	0.	250.	0.050	72.	0.030
20	20.00	3.33	0.	0.	250.	0.050	72.	0.030
21	20.00	3.33	0.	0.	250.	0.050	72.	0.030
22	20.00	3.33	0.	0.	250.	0.050	72.	0.030
23	20.00	3.33	0.	0.	250.	0.050	72.	0.030
24	20.00	3.33	0.	0.	250.	0.050	72.	0.030
25	20.00	3.33	0.	0.	250.	0.050	72.	0.030
26	20.00	3.33	0.	0.	250.	0.050	72.	0.030
27	20.00	3.33	0.	0.	250.	0.050	72.	0.030
28	20.00	3.33	0.	0.	250.	0.050	72.	0.030
29	20.00	3.33	0.	0.	250.	0.050	72.	0.030
30	20.00	3.33	0.	0.	250.	0.050	72.	0.030
31	20.00	3.33	0.	0.	250.	0.050	72.	0.030
32	20.00	3.33	0.	0.	250.	0.050	72.	0.030
33	20.00	3.33	0.	0.	250.	0.050	72.	0.030
34	20.00	3.33	0.	0.	250.	0.050	72.	0.030
35	20.00	3.33	0.	0.	250.	0.050	72.	0.030
36	20.00	3.33	0.	0.	250.	0.050	72.	0.030
37	20.00	3.33	0.	0.	250.	0.050	72.	0.030
38	20.00	3.33	0.	0.	250.	0.050	72.	0.030
39	20.00	3.33	0.	0.	250.	0.050	72.	0.030
40	20.00	3.33	0.	0.	250.	0.050	72.	0.030

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	1 2011.	2 2012.	3 2013.	4 2014.	5 2015.
ANNUAL OIL PRODUCTION, MSTB	264.30	245.61	211.40	190.08	173.82
ANNUAL GAS PRODUCTION, MMSCF	87.22	81.05	69.76	62.73	57.36
ANNUAL WATER PRODUCTION, MSTB	539.	562.	606.	633.	654.
OIL PRODUCTION RATE, STB/D	724.	673.	579.	521.	476.
GAS PRODUCTION RATE, MSCF/D	239.	222.	191.	172.	157.
WATER PRODUCTION RATE, STB/D	1476.	1540.	1661.	1735.	1792.
NET OIL SOLD (LESS ROYALTY), MSTB	231.26	214.91	184.97	166.32	152.09
NET GAS SOLD (LESS ROYALTY), MMSCF	76.32	70.92	61.04	54.88	50.19
MEAN PRICE OF OIL, S/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	5.29	4.91	4.23	3.80	3.48
ANNUAL GROSS GAS SALES, MM$	0.29	0.27	0.23	0.21	0.19
ANNUAL TOTAL GROSS SALES, MM$	5.58	5.18	4.46	4.01	3.67
ANNUAL ROYALTY, MM$	0.70	0.65	0.56	0.50	0.46
ANNUAL NET SALES, MM$	4.88	4.53	3.90	3.51	3.21
ANNUAL SEVERANCE TAX, MM$	0.39	0.36	0.31	0.28	0.26
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL PROD WATER TREATING COST, MM$	0.02	0.02	0.02	0.02	0.02
ANNUAL OVERHEAD, MM$	0.38	0.07	0.07	0.07	0.07
ANNUAL TOTAL OPERATING COST, MM$	1.12	0.78	0.73	0.70	0.68
ANNUAL NET OPERATING INCOME, MM$	3.76	3.75	3.17	2.81	2.53
CUM NET OPERATING INCOME, MM$	3.76	7.51	10.68	13.48	16.02
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.45	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	5.78	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	-2.48	1.27	4.44	7.25	9.78
BASE PRICE OF OIL FOR WPT, $/BBL	23.07	24.68	26.41	28.26	30.24
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.15	0.15	0.13	0.11	0.10
ANNUAL INTANGIBLES AND DEPR, MM$	5.87	0.09	0.09	0.09	0.09
ANNUAL INVESTMENT TAX CREDIT, MM$	0.05	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	-2.27	3.51	2.95	2.60	2.34
ANNUAL FEDERAL INCOME TAX, MM$	-1.09	1.61	1.36	1.20	1.08
ANNUAL AFTER TAX CASH FLOW, MM$	-1.54	1.99	1.68	1.50	1.35
CUM CASH FLOW AFTER TAXES, MM$	-1.54	0.45	2.13	3.63	4.98

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	6 2016.	7 2017.	8 2018.	9 2019.	10 2020.
ANNUAL OIL PRODUCTION, MSTB	161.00	150.80	142.44	135.35	129.21
ANNUAL GAS PRODUCTION, MMSCF	53.13	49.76	47.01	44.66	42.64
ANNUAL WATER PRODUCTION, MSTB	670.	684.	694.	703.	711.
OIL PRODUCTION RATE, STB/D	441.	413.	390.	371.	354.
GAS PRODUCTION RATE, MSCF/D	146.	136.	129.	122.	117.
WATER PRODUCTION RATE, STB/D	1837.	1873.	1902.	1927.	1948.
NET OIL SOLD (LESS ROYALTY), MSTB	140.87	131.95	124.64	118.43	113.06
NET GAS SOLD (LESS ROYALTY), MMSCF	46.49	43.54	41.13	39.08	37.31
MEAN PRICE OF OIL, S/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	3.22	3.02	2.85	2.71	2.58
ANNUAL GROSS GAS SALES, MM$	0.18	0.17	0.16	0.15	0.14
ANNUAL TOTAL GROSS SALES, MM$	3.40	3.18	3.01	2.86	2.73
ANNUAL ROYALTY, MM$	0.42	0.40	0.38	0.36	0.34
ANNUAL NET SALES, MM$	2.97	2.78	2.63	2.50	2.39
ANNUAL SEVERANCE TAX, MM$	0.24	0.22	0.21	0.20	0.19
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL PROD WATER TREATING COST, MM$	0.02	0.02	0.02	0.02	0.02
ANNUAL OVERHEAD, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL TOTAL OPERATING COST, MM$	0.66	0.64	0.63	0.62	0.61
ANNUAL NET OPERATING INCOME, MM$	2.31	2.14	2.00	1.88	1.77
CUM NET OPERATING INCOME, MM$	18.33	20.47	22.47	24.35	26.12
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0 00	0 00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0 00	0 00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	12.10	14.24	16.24	18.12	l9.89
BASE PRICE OF OIL FOR WPT, $/BBL	32.36	34.62	37.05	39.64	42.41
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.09	0.09	0.08	0.08	0.07
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0 00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0 00	0.00	0 00
ANNUAL NET TAXABLE INCOME, MM$	2.22	2.06	1.92	1.80	1.70
ANNUAL FEDERAL INCOME TAX, MM$	1.02	0.95	0.88	0.83	0.78
ANNUAL AFTER TAX CASH FLOW, MM$	1.20	1.11	1.04	0.97	0.92
CUM CASH FLOW AFTER TAXES, MM$	6.18	7.29	8.33	9.30	10.22

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	11 2021.	12 2022.	13 2023.	14 2024.	15 2025.
ANNUAL OIL PRODUCTION, MSTB	123.87	119.14	114.85	110.78	107.15
ANNUAL GAS PRODUCTION, MMSCF	40.88	39.32	37.90	36.56	35.36
ANNUAL WATER PRODUCTION, MSTB	718.	724.	730.	735.	739.
OIL PRODUCTION RATE, STB/D	339.	326.	315.	304.	294.
GAS PRODUCTION RATE, MSCF/D	112.	108.	104.	100.	97.
WATER PRODUCTION RATE, STB/D	1967.	1984.	1999.	2013.	2026.
NET OIL SOLD {LESS ROYALTY), MSTB	108.39	104.25	100.50	96.93	93.76
NET GAS SOLD {LESS ROYALTY), MMSCF	35.77	34.40	33.16	31.99	30.94
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	2.48	2.38	2.30	2.22	2.14
ANNUAL GROSS GAS SALES, MM$	0.14	0.13	0.13	0.12	0.12
ANNUAL TOTAL GROSS SALES, MM$	2.61	2.51	2.42	2.34	2.26
ANNUAL ROYALTY, MM$	0.33	0.31	0.30	0.29	0.28
ANNUAL NET SALES, MM$	2.29	2.20	2.12	2.05	1.98
ANNUAL SEVERANCE TAX, MM$	0.18	0.18	0.17	0.16	0.16
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL PROD WATER TREATING COST, MM$	0.02	0.02	0.02	0.02	0.02
ANNUAL OVERHEAD, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL TOTAL OPERATING COST, MM$	0.60	0.60	0.59	0.58	0.58
ANNUAL NET OPERATING INCOME, MM$	1.68	1.60	1.53	1.46	1.40
CUM NET OPERATING INCOME, MM$	27.81	29.41	30.94	32.41	33.81
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	21.58	23.18	24.71	26.17	27.57
BASE PRICE OF OIL FOR WPT, $/BBL	45.38	48.56	51.96	55.60	59.49
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0,00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.07	0.06	0.06	0.06	0.06
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	1.62	1.54	1.47	1.40	1.34
ANNUAL FEDERAL INCOME TAX, MM$	0.74	0.71	0.68	0.65	0.62
ANNUAL AFTER TAX CASH FLOW, MM$	0.87	0.83	0.79	0.76	0.73
CUM CASH FLOW AFTER TAXES, MM$	11.10	11.93	12.72	13.48	14.20

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	16 2026.	17 2027.	18 2028.	19 2029.	20 2030.
ANNUAL OIL PRODUCTION, MSTB	103.68	100.58	97.64	94.82	92.24
ANNUAL GAS PRODUCTION, MMSCF	34.22	33.19	32.22	31.29	30.44
ANNUAL WATER PRODUCTION, MSTB	744.	748.	752.	755.	759.
OIL PRODUCTION RATE, STB/D	284.	276.	267.	260.	253.
GAS PRODUCTION RATE, MSCF/D	94.	91.	88.	86.	83.
WATER PRODUCTION RATE, STB/D	2038.	2049.	2060.	2069.	2078.
NET OIL SOLD {LESS ROYALTY), MSTB	90.72	88.01	85.43	82.96	80.71
NET GAS SOLD {LESS ROYALTY), MMSCF	29.94	29.04	28.19	27.38	26.63
MEAN PRICE OF OIL, $/BBL	20.22	20.22	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	2.07	2.01	1.95	1.90	1.84
ANNUAL GROSS GAS SALES, MM$	0.11	0.11	0.11	0.10	0.10
ANNUAL TOTAL GROSS SALES, MM$	2.19	2.12	2.06	2.00	1.95
ANNUAL ROYALTY, MM$	0.27	0.27	0.26	0.25	0.24
ANNUAL NET SALES, MM$	1.91	1.86	1.80	1.75	1.70
ANNUAL SEVERANCE TAX, MM$	0.15	0.15	0.14	0.14	0.14
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.01	0.01	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL PROD WATER TREATING COST, MM$	0.02	0.02	0.02	0.02	0.02
ANNUAL OVERHEAD, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL TOTAL OPERATING COST, MM$	0.57	0.57	0.56	0.56	0.56
ANNUAL NET OPERATING INCOME, MM$	1.34	1.29	1.24	1.19	1.15
CUM NET OPERATING INCOME, MM$	35.15	36.44	37.68	38.87	40.02
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	28.92	30.20	31.44	32.63	33.78
BASE PRICE OF OIL FOR WPT, $/BBL	63.65	68.11	72.87	77.98	83.43
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.05	0.05	0.05	0.05	0.05
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	1.29	1.24	1.19	1.14	1.10
ANNUAL FEDERAL INCOME TAX, MM$	0.59	0.57	0.55	0.53	0.51
ANNUAL AFTER TAX CASH FLOW, MM$	0.70	0.67	0.64	0.62	0.59
CUM CASH FLOW AFTER TAXES, MM$	14.90	15.57	16.21	16.83	17.42

PROJECT ECONOMIC ANALYSIS

DISCOUNTED MEAN VALUES

YEAR ENDING	21 2031	22 2032	23 2033	24 2034	25 2035.
ANNUAL OIL PRODUCTION, MSTB	89.75	87.38	85.l4	83.06	80.99
ANNUAL GAS PRODUCTION, MMSCF	29.62	28.84	28.09	27.41	26.73
ANNUAL WATER PRODUCTION, MSTB	762.	765.	768.	770.	773.
OIL PRODUCTION RATE, STB/D	246.	239.	233.	228.	222.
GAS PRODUCTION RATE, MSCF/D	81.	79.	77.	75.	73.
WATER PRODUCTION RATE, STB/D	2087.	2095.	2103.	2111.	2117.
NET OIL SOLD (LESS ROYALTY), MSTB	78.53	76.46	74.49	72.68	70.86
NET GAS SOLD (LESS ROYALTY), MMSCF	25.91	25.23	24.58	23.98	23.38
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, S/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	1.79	1.75	1.70	1.66	1.62
ANNUAL GROSS GAS SALES, MM$	0.10	0.10	0.09	0.09	0.09
ANNUAL TOTAL GROSS SALES, MM$	1.89	1.84	1.80	1.75	1.71
ANNUAL ROYALTY, MM$	0.24	0.23	0.22	0.22	0.21
ANNUAL NET SALES, MM$	1.66	1.61	1.57	1.53	1.50
ANNUAL SEVERANCE TAX, MM$	0.13	0.13	0.13	0.12	0.12
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL PROD WATER TREATING COST, MM$	0.02	0.02	0.02	0.02	0.02
ANNUAL OVERHEAD, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL TOTAL OPERATING COST, MM$	0.55	0.55	0.54	0.54	0.54
ANNUAL NET OPERATING INCOME, MM$	1.11	1.07	1.03	0.99	0.96
CUM NET OPERATING INCOME, MM$	41.12	42.19	43.21	44.20	45.16
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	34.89	35.95	36.98	37.97	38.93
BASE PRICE OF OIL FOR WPT, S/BBL	89.27	95.52	102.21	109.36	117.02
ANNUAL WINDFALL PRICE DIFF, S/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.04	0.04	0.04	0.04	0.04
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	1.06	1.02	0.99	0.95	0.92
ANNUAL FEDERAL INCOME TAX, MM$	0.49	0.47	0.45	0.44	0.42
ANNUAL AFTER TAX CASH FLOW, MM$	0.57	0.55	0.53	0.51	0.50
CUM CASH FLOW AFTER TAXES, MM$	18.00	18.55	19.08	19.59	20.09

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	26 2036	27 2037	28 2038	29 2039	30 2040.
ANNUAL OIL PRODUCTION, MSTB	79.03	77.18	75.34	73.65	72.00
ANNUAL GAS PRODUCTION, MMSCF	26.08	25.47	24.86	24.30	23.76
ANNUAL WATER PRODUCTION, MSTB	775.	778.	780.	783.	785.
OIL PRODUCTION RATE, STB/D	217.	211.	206.	202.	197.
GAS PRODUCTION RATE, MSCF/D	71.	70.	68.	67.	65.
WATER PRODUCTION RATE, STB/D	2124.	2132.	2138.	2144	2150
NET OIL SOLD (LESS ROYALTY), MSTB	69.15	67.53	65.92	64.44	63.00
NET GAS SOLD (LESS ROYALTY), MMSCF	22.82	22.29	21.75	21.27	20.79
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, S/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	1.58	1.54	1.51	1.47	1.44
ANNUAL GROSS GAS SALES, MM$	0.09	0.08	0.08	0.08	0.08
ANNUAL TOTAL GROSS SALES, MM$	1.67	1.63	1.59	1.55	1.52
ANNUAL ROYALTY, MM$	0.21	0.20	0.20	0.19	0.19
ANNUAL NET SALES, MM$	1.46	1.42	1.39	1.36	1.33
ANNUAL SEVERANCE TAX, MM$	0.12	0.11	0.11	0.11	0.11
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0 00	0 00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL PROD WATER TREATING COST, MM$	0.02	0.02	0.02	0.02	0.02
ANNUAL OVERHEAD, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL TOTAL OPERATING COST, MM$	0.54	0.53	0.53	0.53	0.53
ANNUAL NET OPERATING INCOME, MM$	0.92	0.89	0.86	0.83	0.80
CUM NET OPERATING INCOME, MM$	46.08	46.98	47.84	48.67	49.47
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0 00	0 00	0 00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	39.85	40.74	41.60	42.44	43.24
BASE PRICE OF OIL FOR WPT, S/BBL	125.21	133.98	143.35	153.39	164.13
ANNUAL WINDFALL PRICE DIFF, S/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.04	0.04	0.03	0.03	0.03
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	0.89	0.86	0.83	0.80	0.77
ANNUAL FEDERAL INCOME TAX, MM$	0.41	0.39	0.38	0.37	0.36
ANNUAL AFTER TAX CASH FLOW, MM$	0.48	0.46	0.45	0.43	0.42
CUM CASH FLOW AFTER TAXES, MM$	20.57	21.03	21.48	21.91	22.33

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	31 2041.	32 2042.	33 2043.	34 2044.	35 2045.
ANNUAL OIL PRODUCTION, MSTB	70.32	68.70	67.10	65.61	64.21
ANNUAL GAS PRODUCTION, MMSCF	23.20	22.67	22.14	21.65	21.19
ANNUAL WATER PRODUCTION, MSTB	787.	789.	791.	793.	795.
OIL PRODUCTION RATE, STB/D	193.	188.	184.	180.	176.
GAS PRODUCTION RATE, MSCF/D	64.	62.	61.	59.	58.
WATER PRODUCTION RATE, STB/D	2156.	2161.	2167.	2172.	2177.
NET OIL SOLD (LESS ROYALTY), MSTB	61.53	60.11	58.71	57.41	56.18
NET GAS SOLD (LESS ROYALTY), MMSCF	20.30	19.84	19.38	18.95	18.54
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	1.41	1.37	1.34	1.31	1.28
ANNUAL GROSS GAS SALES, MM$	0.08	0.08	0.07	0.07	0.07
ANNUAL TOTAL GROSS SALES, MM$	1.48	1.45	1.42	1.38	1.35
ANNUAL ROYALTY, MM$	0.19	0.18	0.18	0.17	0.17
ANNUAL NET SALES, MM$	1.30	1.27	1.24	1.21	1.19
ANNUAL SEVERANCE TAX, MM$	0.10	0.10	0.10	0.10	0.09
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL PROD WATER TREATING COST, MM$	0.02	0.02	0.02	0.02	0.02
ANNUAL OVERHEAD, MM$	0.07	0.07	0.07	0.07	0.07
ANNUAL TOTAL OPERATING COST, MM$	0.52	0.52	0.52	0.52	0.51
ANNUAL NET OPERATING INCOME, MM$	0.78	0.75	0.72	0.70	0.67
CUM NET OPERATING INCOME, MM$	50.25	51.00	51.72	52.41	53.08
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	44.01	44.76	45.48	46.18	46.85
BASE PRICE OF OIL FOR WPT, $/BBL	175.61	187.91	201.06	215.14	230.20
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.03	0.03	0.03	0.03	0.03
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	0.74	0.72	0.69	0.67	0.64
ANNUAL FEDERAL INCOME TAX, MM$	0.34	0.33	0.32	0.31	0.30
ANNUAL AFTER TAX CASH FLOW, MM$	0.40	0.39	0.37	0.36	0.35
CUM CASH FLOW AFTER TAXES, MM$	22.73	23.12	23.49	23.85	24.20

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	36 2046.	37 2047	38 2048.	39 2049.	40 2050
ANNUAL OIL PRODUCTION, MSTB	62.79	61.45	60.16	59.00	57.76
ANNUAL GAS PRODUCTION, MMSCF	20.72	20.28	19.85	19.47	19.06
ANNUAL WATER PRODUCTION, MSTB	797.	798.	800.	801.	803.
OIL PRODUCTION RATE, STB/D	172.	168.	165.	162.	158.
GAS PRODUCTION RATE, MSCF/D	57.	56.	54	53.	52.
WATER PRODUCTION RATE, STB/D	2183.	2187.	2192.	2196.	2200.
NET OIL SOLD (LESS ROYALTY), MSTB	54.94	53.77	52.64	51.62	50.54
NET GAS SOLD (LESS ROYALTY), MMSCF	18.13	17.74	17.37	17.03	16.68
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	1.26	1.23	1.20	1.18	1.16
ANNUAL GROSS GAS SALES, MM$	0.07	0.07	0.07	0.06	0.06
ANNUAL TOTAL GROSS SALES, MM$	1.32	1.30	1.27	1.24	1.22
ANNUAL ROYALTY, MM$	0.17	0.16	0.16	0.16	0.15
ANNUAL NET SALES, MM$	1.16	1.13	1.11	1.09	1.07
ANNUAL SEVERANCE TAX, MM$	0.09	0.09	0.09	0.09	0.09
ANNUAL FIXED OPERATING COST, MM$	0.25	0.25	0.25	0.25	0.25
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	O.07	O.07	0.07	O.07	O.07
ANNUAL PROD WATER TREATING COST, MM$	0.02	0.02	0.02	0.02	0.02
ANNUAL OVERHEAD, MM$	0.07	O.07	0.07	O.07	O.07
ANNUAL TOTAL OPERATING COST, MM$	0.51	0.51	0.51	O.51	0.50
ANNUAL NET OPERATING INCOME, MM$	0.65	0.62	0.60	0.58	0.56
CUM NET OPERATING INCOME, MM$	53.73	54.36	54.96	55.54	56.11
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	47.50	48.12	48.73	49.31	49.87
BASE PRICE OF OIL FOR WPT, $/BBL	246.31	263.55	282.00	301.74	322.86
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.03	0.02	0.02	0.02	0.02
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0 00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	0.62	0.60	0.58	0.56	0.54
ANNUAL FEDERAL INCOME TAX, MM$	0.29	0.28	0.27	0.26	0.25
ANNUAL AFTER TAX CASH FLOW, MM$	0.34	0.32	0.31	0.30	0.29
CUM CASH FLOW AFTER TAXES, MM$	24.53	24.86	25.17	25.47	25.76

UNDISCOUNTED MEAN RESULTS

PROJECT ECONOMIC LIFE	40.0	YEARS
TOTAL GROSS SALES	90.923	MM$
TOTAL NET SALES	79.557	MM$
TOTAL SEVERANCE TAX	6.365	MM$
TOTAL FIXED OPERATING COST	9.994	MM$
TOTAL VARIABLE OPERATING COST	0.215	MM$
TOTAL WELL WORKOVER COST	2.883	MM$
TOTAL PROD WATER TREATING COST	0.887	MM$
TOTAL OVERHEAD	3.108	MM$
TOTAL OPERATING COST	23.451	MM$
TOTAL WORKING CAPITAL	0.000	MM$
TOTAL TANGIBLE CAPITAL	5.780	MM$
TOTAL INTANGIBLE CAPITAL	6.233	MM$
TOTAL CAPITAL INVESTMENT	6.233	MM$
TOTAL DEBT INTEREST	0.000	MM$
TOTAL PROJECT EXPENSE	29.685	MM$

TOTAL CASH FLOW BEFORE TAX	49.873	MM$
TOTAL WINDFALL PROFITS TAX	0.000	MM$
TOTAL STATE INCOME TAX	2.244	MM$
TOTAL FEDERAL INCOME TAX	21.864	MM$
TOTAL AFTER TAX CASH FLOW	25.765	MM$
TOTAL LOAN AMOUNT	0.000	MM$

PROJECT ECONOMIC ANALYSIS

		PRESNT	------------------MEAN VALUE CASH FLOW------------------					
		VALUE	------BEFORE TAX (MM$)------			------AFTER TAX (MM$)-----		
	YEAR	FACTOR	ANNUAL	CONST $	DISCNTD	ANNUAL	CONST $	DISCNTD
1	2011.	1.0000	-2.48	-2.48	-2.48	-1.54	-1.54	-1.54
2	2012.	0.8658	1.27	1.09	0.77	0.45	0.35	0.18
3	2013.	0.7496	4.44	3.97	3.15	2.13	1.88	1.44
4	2014.	0.6490	7.25	6.39	4.97	3.63	3.17	2.41
5	2015.	0.5619	9.78	8.48	6.39	4.98	4.29	3.17
6	2016.	0.4865	12.10	10.29	7.52	6.18	5.23	3.76
7	2017.	0.4212	14.24	11.89	8.42	7.29	6.05	4.23
8	2018.	0.3647	16.24	13.31	9.15	8.33	6.79	4.60
9	2019.	0.3158	18.12	14.58	9.74	9.30	7.45	4.91
10	2020.	0.2734	19.89	15.73	10.23	10.22	8.04	5.16
11	2021.	0.2367	21.58	16.76	10.62	11.10	8.58	5.37
12	2022.	0.2049	23.18	17.70	10.95	11.93	9.07	5.54
13	2023.	0.1774	24.71	18.55	11.23	12.72	9.51	5.68
14	2024.	0.1536	26.17	19.33	11.45	13.48	9.91	5.80
15	2025.	0.1330	27.57	20.03	11.64	14.20	10.28	5.89
16	2026.	0.1152	28.92	20.68	11.79	14.90	10.61	5.97
17	2027.	0.0997	30.20	21.27	11.92	15.57	10.92	6.04
18	2028.	0.0863	31.44	21.81	12.03	16.21	11.20	6.10
19	2029.	0.0747	32.63	22.30	12.12	16.83	11.45	6.14
20	2030.	0.0647	33.78	22.76	12.19	17.42	11.69	6.18
21	2031.	0.0560	34.89	23.18	12.25	18.00	11.91	6.21
22	2032.	0.0485	35.95	23.56	12.30	18.55	12.10	6.24
23	2033.	0.0420	36.98	23.91	12.35	19.08	12.29	6.26
24	2034.	0.0364	37.97	24.23	12.38	19.59	12.45	6.28
25	2035.	0.0315	38.93	24.53	12.41	20.09	12.61	6.30
26	2036.	0.0273	39.85	24.80	12.44	20.57	12.75	6.31
27	2037.	0.0236	40.74	25.05	12.46	21.03	12.88	6.32
28	2038.	0.0204	41.60	25.28	12.48	21.48	13.00	6.33
29	2039.	0.0177	42.44	25.49	12.49	21.91	13.11	6.34
30	2040.	0.0153	43.24	25.69	12.50	22.33	13.21	6.34
31	2041.	0.0133	44.01	25.87	12.51	22.73	13.30	6.35
32	2042.	0.0115	44.76	26.03	12.52	23.12	13.39	6.35
33	2043.	0.0099	45.48	26.19	12.53	23.49	13.47	6.36
34	2044.	0.0086	46.18	26.32	12.53	23.85	13.54	6.36
35	2045.	0.0075	46.85	26.45	12.54	24.20	13.60	6.36
36	2046.	0.0065	47.50	26.57	12.54	24.53	13.67	6.36
37	2047.	0.0056	48.12	26.68	12.55	24.86	13.72	6.37
38	2048.	0.0048	48.73	26.78	12.55	25.17	13.77	6.37
39	2049.	0.0042	49.31	26.87	12.55	25.47	13.82	6.37
40	2050.	0.0036	49.87	26.95	12.56	25.76	13.86	6.37

S C I E N T I F I C S O F T W A R E
I N T E R C O M P

INFILL DRILLING PREDICTION MODEL
(IDPM - RELEASE 1.2.0)

Economics for Infill Waterflood

PRODUCTION SUMMARY

PROJECT ECONOMIC LIFE 40.0 YEARS

CUMULATIVE GROSS OIL SOLD	4309.	MSTB
CUMULATIVE GROSS GAS SOLD	1422.	MMSCF
CUMULATIVE NET OIL SOLD	3771.	MSTB
PRESENT VALUE OF NET OIL SOLD	1145.	MSTB

MEAN RESULTS

PRESENT VALUE OF TOTAL GROSS SALES	27.606	MM$
PRESENT VALUE OF TOTAL NET SALES	24.155	MM$
TOTAL SEVERANCE TAX (PV)	1.932	MM$
TOTAL FIXED OPERATING COST (PV)	1.856	MM$
TOTAL VARIABLE OPERATING COST (PV)	0.065	MM'
TOTAL WELL WORKOVER COST (PV)	0.535	MM$
TOTAL PROD WATER TREATING COST (PV)	0.145	MM$
TOTAL OVERHEAD (PV)	0.832	MM$
TOTAL OPERATING COST (PV)	5.366	MM$
TOTAL WORKING CAPITAL (PV)	0.000	MM$
TOTAL TANGIBLE CAPITAL INVESTED (PV)	0.453	MM$
TOTAL INTANGIBLE CAPITAL (PV)	5.780	MM$
TOTAL CAPITAL INVESTMENT (PV)	6.233	MM$
TOTAL INTEREST EXPENSE (PV)	0.000	MM$
TOTAL PROJECT EXPENSE (PV)	11.600	MM$
TOTAL LOAN PRINCIPAL REPAYMENT (PV)	0.000	MM$
DISCOUNTED COST PER DISC NET OIL	10.132	$/BBL
DISCOUNTED CASH FLOW BEFORE TAX	12.555	MM$

PROJECT PROFITABILITY (AFTER TAX)

AVERAGE MONETARY DISCOUNT RATE	10.00	PCNT
90 PCNT CONFIDENCE DCF	2.729	MM$
MEAN DISCOUNTED CASH FLOW	6.370	MM$
10 PCNT CONFIDENCE DCF	10.638	MM$
STANDARD DEVIATION OF THE MEAN DCF	2.984	MM$
MEAN DCF PROFIT TO INVESTMENT RATIO	1.022	P/I
MEAN DCF PROFIT TO EXPENSE RATIO	0.549	P/E
MEAN DCF PROFIT PER DISC NET OIL	5.564	$/BBL
MEAN INVESTMENT EFFICIENCY	2.336	
MEAN DCF RATE OF RETURN	53.47	PCNT

S C I E N T I F I C S O F T W A R E
I N T E R C O M P

INFILL DRILLING PREDICTION MODEL
(IDPM - RELEASE 1.2.0)

Economics for Infill over Non-Infill

ECONOMIC DATA

NUMBER OF PROJECT YEARS	40	
STATE CODE	NONE	
DISTRICT CODE	0	
PRINT CONTROL	2	IOUT
FEDERAL INCOME TAX OPTION	0	IFIT
DISCOUNTING METHOD	0	IDISC
DEPRECIATION METHOD	0	IDEP
PROJECT ECONOMIC LIFE METHOD	0	IPLIF
RESERVOIR DEPTH	6300.0	FEET
INJECTORS DRILLED PER PATTERN (WPP1).	0.00	
PRODUCERS DRILLED PER PATTERN (WPP2).	2.00	
CONVTD PRIMARY PROD PER PAT (WPP3)	0.00	
CONVTD PROD TO INJ PER PAT (WPP4)	1.00	
NO. OF MONTHS WORKING CAPITAL	0.00	
PROJECT STARTUP COSTS	0.0	M$
OIL RATE UNCERTAINTY	0.0010	FRACTION
PERCENT OF CAPITAL BORROWED	0	PERCENT

TAXES AND ESCALATION

DISCOUNT RATE	0.100	FRACTION
INFLATION RATE	0.050	FRACTION
ROYALTY RATE	0.125	FRACTION
SEVERANCE TAX RATE	0.080	FRACTION
FEDERAL INCOME TAX RATE	0.460	FRACTION
INVESTMENT TAX CREDIT	0.100	FRACTION
DEPRECIATION TIME (STRAIGHT LINE)	5.00	YEARS
STATE INCOME TAX RATE	0.040	FRACTION
WINDFALL EXCISE TAX RATE	0.000	FRACTION
WINDFALL PHASE OUT START DATE	1991.	
WINDFALL PHASE OUT END DATE	1993.	
PROJECT START DATE	1994.	
BASE OIL PRICE EOR WINDFALL TAX	23.07	S/BBL
OIL PRICE ESCALATION RATE	0.000	FRACTION
GAS PRICE ESCALATION RATE	0.000	FRACTION
OPERATING COST ESCALATION RATE	0.000	FRACTION

PRICES AND COSTS		LOW	MOST-LIKELY	HIGH
OIL PRICE	$/BBL	16.00	20.00	24.00
GAS PRICE	$/MCF	2.67	3.33	4.00
FIXED OPERATING COST PER PATTERN	S/YR	33313.	41642.	49970.
VARIABLE OPERATING COST	$/BBL	0.040	0.050	0.060
WELL WORKOVER COST PER PATTERN	$/YR		12013.	
PROD WATER TREATING/DISPOSAL COST	$/BBL		0.030	

NOTE: -PATTERN- HERE ALWAYS REFERS TO THE PRE-INFILL FULL 5-SPOT PATTERN

ANNUAL PATTERN AND PROJECT VOLUMES PRODUCED

PROJECT LIFE IS 40 YEARS
PROJECT INITIATED AT 17.50 YEARS OF NON -INFILL PROJECT

	--------------PATTERN--------------					-----------------PROJECT-------------				
YR	INJ OIL, MSTB	GAS, MMSCF	WATER, MSTB	YR-END WTR-CUT	WTR, MSTB	PATTERNS INITIATD	PATTERNS TOTAL	OIL, MSTB	GAS, MMSCF	WATER, MSTB
1	27.5	9.1	38.3	0.6754	73.1	6.	6.	165.0	54.4	229.6
2	25.0	8.3	41.2	0.7218	73.1	0.	6.	150.3	49.6	247.1
3	20.0	6.6	47.8	0.7553	73.1	0.	6.	119.8	39.5	286.5
4	17.0	5.6	51.5	0.7799	73.1	0.	6.	101.8	33.6	309.0
5	14.8	4.9	54.3	0.7982	73.1	0.	6.	88.5	29.2	325.7
6	13.1	4.3	56.4	0.8127	73.1	0.	6.	78.6	25.9	338.3
7	11.9	3.9	57.9	0.8243	73.1	O.	6.	71.1	23.5	347.7
8	10.9	3.6	59.2	0.8339	73.1	0.	6.	65.3	21.6	355.4
9	10.1	3.3	60.2	0.8419	73.1	0.	6.	60.6	20.0	361.1
10	9.4	3.1	61.0	0.8495	73.1	O.	6.	56.5	18.6	366.2
11	8.9	2.9	61.7	0.8557	73.1	0.	6.	53.4	17.6	370.5
12	8.4	2.8	62.4	0.8614	73.1	0.	6.	50.5	16.7	374.1
13	8.0	2.6	62.9	0.8662	73.1	0.	6.	48.1	15.9	377.2
14	7.6	2.5	63.3	0.8710	73.1	0.	6.	45.7	15.1	379.9
15	7.3	2.4	63.7	0.8755	73.1	0.	6.	43.8	14.4	382.4
16	7.0	2.3	64.1	0.8794	73.1	0.	6.	41.9	13.8	384.6
17	6.7	2.2	64.4	0.8832	73.1	O.	6.	40.3	13.3	386.6
18	6.4	2.1	64.8	0.8866	73.1	0.	6.	38.6	12.8	388.6
19	6.2	2.0	65.1	0.8898	73.1	0.	6.	37.3	12.3	390.3
20	6.0	2.0	65.3	0.8932	73.1	0.	6.	35.9	11.9	392.0
21	5.8	1.9	65.6	0.8959	73.1	0.	6.	34.9	11.5	393.7
22	5.6	1.9	65.8	0.8987	73.1	0.	6.	33.8	11.1	395.0
23	5.5	1.8	66.1	0.9014	73.1	0.	6.	32.7	10.8	396.5
24	5.3	1.8	66.3	0.9038	73.1	0.	6.	31.9	10.5	397.8
25	5.1	1.7	66.5	0.9063	73.1	0.	6.	30.8	10.2	399.1
26	5.0	1.6	66.6	0.9084	73.1	0.	6.	30.0	9.9	399.8
27	4.9	1.6	66.9	0.9111	73.1	0.	6.	29.1	9.6	401.4
28	4.7	1.6	67.1	0.9132	73.1	0.	6.	28.4	9.4	402.4
29	4.6	1.5	67.3	0.9151	73.1	0.	6.	27.6	9.1	403.5
30	4.5	1.5	67.4	0.9169	73.1	0.	6.	26.8	8.9	404.3
31	4.3	1.4	67.5	0.9188	73.1	0.	6.	26.0	8.6	405.2
32	4.2	1.4	67.7	0.9210	73.1	0.	6.	25.2	8.3	406.2
33	4.1	1.3	67.9	0.9225	73.1	0.	6.	24.5	8.1	407.3
34	4.0	1.3	68.0	0.9243	73.1	0.	6.	23.8	7.9	408.2
35	3.9	1.3	68.2	0.9257	73.1	0.	6.	23.1	7.6	409.2
36	3.8	1.2	68.3	0.9277	73.1	0.	6.	22.5	7.4	409.9
37	3.6	1.2	68.4	0.9291	73.1	0.	6.	21.9	7.2	410.6
38	3.5	1.2	68.6	0.9306	73.1	0.	6.	21.3	7.0	411.3
39	3.5	1.1	68.6	0.9318	73.1	0.	6.	20.8	6.9	411.7
40	3.4	1.1	68.7	0.9331	73.1	0.	6.	20.3	6.7	412.4

MAJOR CAPITAL COSTS

INJECTOR DRILLING COST	0.	$/WELL
PRODUCER EQUIPMENT COST	128487.	$/WELL
COST TO UPGRADE SECONDARY PROD	0.	$/WELL
COST TO CONVERT PROD TO INJ	48050.	$/WELL
COST TO UPGRADE TO SEC. OPERATIONS	30297.	$/WELL
CAPACITY OF WATER INJ PLANT	0.4	MMB/YR
CAPITAL EOR WATER INJ PLANT	0.0	M$

PROJECT CAPITAL SCHEDULE - MOST LIKELY

	--- PATTERN $ ---		PATTERNS	--- PROJECT M$ --	
YEAR	TANGIBLE	INTANGBL	INITIATD	TANGIBLE	INTANGBL
1	75550.1	963365.7	6.	453.	5780.
2	0.0	0.0	0.	0.	0.
3	0.0	0.0	0.	0.	0.
4	0.0	0.0	0.	0.	0.
5	0.0	0.0	0.	0.	0.
6	0.0	0.0	0.	0.	0.
7	0.0	0.0	0.	0.	0.
8	0.0	0.0	0.	0.	0.
9	0.0	0.0	0.	0.	0.
10	0.0	0.0	0.	0.	0.
11	0.0	0.0	0.	0.	0.
12	0.0	0.0	0.	0.	0.
13	0.0	0.0	0.	0.	0.
14	0.0	0.0	0.	0.	0.
15	0.0	0.0	0.	0.	0.
16	0.0	0.0	0.	0.	0.
17	0.0	0.0	0.	0.	0.
18	0.0	0.0	0.	0.	0.
19	0.0	0.0	0.	0.	0.
20	0.0	0.0	0.	0.	0.
21	0.0	0.0	0.	0.	0.
22	0.0	0.0	0.	0.	0.
23	0.0	0.0	0.	0.	0.
24	0.0	0.0	0.	0.	0.
25	0.0	0.0	0.	0.	0.
26	0.0	0.0	0.	0.	0.
37	0.0	0.0	0.	0.	0.
28	0.0	0.0	0.	0.	0.
30	0.0	0.0	0.	0.	0.
31	0.0	0.0	0.	0.	0.
32	0.0	0.0	0.	0.	0.
33	0.0	0.0	0.	0.	0.
34	0.0	0.0	0.	0.	0.
35	0.0	0.0	0.	0.	0.
36	0.0	0.0	0.	0.	0.
37	0.0	0.0	0.	0.	0.
38	0.0	0.0	0.	0.	0.
39	0.0	0.0	0.	0.	0.
40	0.0	0.0	0.	0.	0.

PROJECT MEAN VALUES - ESCALATED

YEAR	OIL PRICE $/BBL	GAS PRICE $/MCF	TANGIBLE CAPITAL M$/YR	INTANGBL CAPITAL M$/YR	FIXED OPN COST M$/YR	VARIABLE OPN COST $/BBL	WELL WORKOVER M$/YR	WATER TREATING $/BBL
1	20.00	3.33	453.	5780.	0.	0.050	0.	0.030
2	20.00	3.33	0.	0.	0.	0.050	0.	0.030
3	20.00	3.33	0.	0.	0.	0.050	0.	0.030
4	20.00	3.33	0.	0.	0.	0.050	0.	0.030
5	20.00	3.33	0.	0.	0.	0.050	0.	0.030
6	20.00	3.33	0.	0.	0.	0.050	0.	0.030
7	20.00	3.33	0.	0.	0.	0.050	0.	0.030
8	20.00	3.33	0.	0.	0.	0.050	0.	0.030
9	20.00	3.33	0.	0.	0.	0.050	0.	0.030
10	20.00	3.33	0.	0.	0.	0.050	0.	0.030
11	20.00	3.33	0.	0.	0.	0.050	0.	0.030
12	20.00	3.33	0.	0.	0.	0.050	0.	0.030
13	20.00	3.33	0.	0.	0.	0.050	0.	0.030
14	20.00	3.33	0.	0.	0.	0.050	0.	0.030
15	20.00	3.33	0.	0.	0.	0.050	0.	0.030
16	20.00	3.33	0.	0.	0.	0.050	0.	0.030
17	20.00	3.33	0.	0.	0.	0.050	0.	0.030
18	20.00	3.33	0.	0.	0.	0.050	0.	0.030
19	20.00	3.33	0.	0.	0.	0.050	0.	0.030
20	20.00	3.33	0.	0.	0.	0.050	0.	0.030
21	20.00	3.33	0.	0.	0.	0.050	0.	0.030
22	20.00	3.33	0.	0.	0.	0.050	0.	0.030
23	20.00	3.33	0.	0.	0.	0.050	0.	0.030
24	20.00	3.33	0.	0.	0.	0.050	0.	0.030
25	20.00	3.33	0.	0.	0.	0.050	0.	0.030
26	20.00	3.33	0.	0.	0.	0.050	0.	0.030
27	20.00	3.33	0.	0.	0.	0.050	0.	0.030
28	20.00	3.33	0.	0.	0.	0.050	0.	0.030
29	20.00	3.33	0.	0.	0.	0.050	0.	0.030
30	20.00	3.33	0.	0.	0.	0.050	0.	0.030
31	20.00	3.33	0.	0.	0.	0.050	0.	0.030
32	20.00	3.33	0.	0.	0.	0.050	0.	0.030
33	20.00	3.33	0.	0.	0.	0.050	0.	0.030
34	20.00	3.33	0.	0.	0.	0.050	0.	0.030
35	20.00	3.33	0.	0.	0.	0.050	0.	0.030
36	20.00	3.33	0.	0.	0.	0.050	0.	0.030
37	20.00	3.33	0.	0.	0.	0.050	0.	0.030
38	20.00	3.33	0.	0.	0.	0.050	0.	0.030
39	20.00	3.33	0.	0.	0.	0.050	0.	0.030
40	20.00	3.33	0.	0.	0.	0.050	0.	0.030

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

	1	2	3	4	5
YEAR ENDING	2011.	2012.	2013.	2014.	2015.
ANNUAL OIL PRODUCTION, MSTB	165.00	l50.27	119.75	101.84	88.53
ANNUAL GAS PRODUCTION, MMSCF	54.45	49.59	39.52	33.61	29.21
ANNUAL WATER PRODUCTION, MSTB	230.	247.	287.	309.	326.
OIL PRODUCTION RATE, STB/D	452.	412.	328.	279.	243.
GAS PRODUCTION RATE, MSCF/D	149.	136.	108.	92.	80.
WATER PRODUCTION RATE, STB/D	629.	677.	785.	847.	892.
NET OIL SOLD (LESS ROYALTY), MSTB	144.37	131.49	104.79	89.11	77.46
NET GAS SOLD (LESS ROYALTY), MMSCF	47.64	43.39	34.58	29.41	25.56
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	3.30	3.01	2.40	2.04	1.77
ANNUAL GROSS GAS SALES, MM$	0.18	0.17	0.13	0.11	0.10
ANNUAL TOTAL GROSS SALES, MM$	3.48	3.17	2.53	2.15	1.87
ANNUAL ROYALTY, MM$	0.44	0.40	0.32	0.27	0.23
ANNUAL NET SALES, MM$	3.05	2.77	2.21	1.88	1.63
ANNUAL SEVERANCE TAX, MM$	0.24	0.22	0.18	0.15	0.13
ANNUAL FIXED OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL VARIABLE OPERATING COST, MM$	0.01	0.01	0.01	0.01	0.00
ANNUAL WELL WORKOVER COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL PROD WATER TREATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.31	0.00	0.00	0.00	0.00
ANNUAL TOTAL OPERATING COST, MM$	0.57	0.24	0.19	0.17	0.15
ANNUAL NET OPERATING INCOME, MM$	2.47	2.53	2.02	1.71	1.49
CUM NET OPERATING INCOME, MM$	2.47	5.01	7.02	8.74	10.22
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.45	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	5.78	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	-3.76	-1.23	0.79	2.50	3.99
BASE PRICE OF OIL FOR WPT, $/BBL	23.07	24.68	26.41	28.26	30.24
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.10	0.10	0.08	0.07	0.06
ANNUAL INTANGIBLES AND DEPR, MM$	5.87	0.09	0.09	0.09	0.09
ANNUAL INVESTMENT TAX CREDIT, MM$	0.05	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	-3.50	2.34	1.85	1.55	1.34
ANNUAL FEDERAL INCOME TAX, MM$	-1.65	1.08	0.85	0.71	0.61
ANNUAL AFTER TAX CASH FLOW, MM$	-2.21	1.36	1.09	0.93	0.81
CUM CASH FLOW AFTER TAXES, MM$	-2.21	-0.85	0.24	1.17	1.98

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	6 2016.	7 2017.	8 2018.	9 2019.	10 2020.
ANNUAL OIL PRODUCTION, MSTB	78.57	71.12	65.31	60.56	56.50
ANNUAL GAS PRODUCTION, MMSCF	25.93	23.47	21.55	19.99	18.65
ANNUAL WATER PRODUCTION, MSTB	338.	348.	355.	361.	366.
OIL PRODUCTION RATE, STB/D	215.	195.	179.	166.	155.
GAS PRODUCTION RATE, MSCF/D	71.	64.	59.	55.	51.
WATER PRODUCTION RATE, STB/D	927.	953.	974.	989.	1003.
NET OIL SOLD (LESS ROYALTY), MSTB	68.75	62.23	57.15	52.99	49.44
NET GAS SOLD (LESS ROYALTY), MMSCF	22.69	20.84	18.16	17.49	16.31
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3 33	3 33
ANNUAL GROSS OIL SALES, MM$	1.57	1.42	1.31	1.21	1.13
ANNUAL GROSS GAS SALES, MM$	0.09	0.08	0.07	0.07	0.06
ANNUAL TOTAL GROSS SALES, MM$	1.66	1.50	1.38	1.28	1.19
ANNUAL ROYALTY, MM$	0.21	0.19	0.17	0.16	0.15
ANNUAL NET SALES, MM$	1.45	1.31	1.21	1.12	1.04
ANNUAL SEVERANCE TAX, MM$	0.12	0.11	0.10	0.09	0.08
ANNUAL FIXED OPERATING COST, MM$	0.00	0 00	0 O0	0 00	0 00
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.00	0.00	0 O0	0.00	0.00
ANNUAL PROD WATER TREATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TOTAL OPERATING COST, MM$	0.13	0.12	0.11	0.11	0.10
ANNUAL NET OPERATING INCOME, MM$	1.32	1.19	1.09	1.01	0.94
CUM NET OPERATING INCOME, MM$	11.54	12.73	13.82	14.84	15.78
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0 00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	5.31	6.50	7.59	8.60	9.55
BASE PRICE OF OIL FOR WPT, $/BBL	32.36	34.62	37.05	39.64	42.41
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.05	0.05	0.04	0.04	0.04
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	1.26	1.14	1.05	0.97	0.91
ANNUAL FEDERAL INCOME TAX, MM$	0.58	0.53	0.48	0.45	0.42
ANNUAL AFTER TAX CASH FLOW, MM$	0.68	0.62	0.57	0.52	0.49
CUM CASH FLOW AFTER TAXES, MM$	2.66	3.28	3.85	4.37	4.86

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	11 2021.	12 2022.	13 2023.	14 2024.	15 2025.
ANNUAL OIL PRODUCTION, MSTB	53.38	50.53	48.10	45.72	43.76
ANNUAL GAS PRODUCTION, MMSCF	17.62	16.67	15.87	15.09	14.44
ANNUAL WATER PRODUCTION, MSTB	370.	374.	377.	380.	382.
OIL PRODUCTION RATE, STB/D	146.	138.	132.	125.	120.
GAS PRODUCTION RATE, MSCF/D	48.	46.	43.	41.	40.
WATER PRODUCTION RATE, STB/D	1015.	1025.	1033.	1041.	1048.
NET OIL SOLD (LESS ROYALTY), MSTB	46.71	44.21	42.09	40.01	38.29
NET GAS SOLD (LESS ROYALTY), MMSCF	15.41	14.59	13.89	13.20	12.63
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	1.07	1.01	0.96	0.91	0.88
ANNUAL GROSS GAS SALES, MM$	0.06	0.06	0.05	0.05	0.05
ANNUAL TOTAL GROSS SALES, MM$	1.13	1.07	1.01	0.96	0.92
ANNUAL ROYALTY, MM$	0.14	0.13	0.13	0.12	0.12
ANNUAL NET SALES, MM$	0.99	0.93	0.89	0.84	0.81
ANNUAL SEVERANCE TAX, MM$	0.08	0.07	0.07	0.07	0.06
ANNUAL FIXED OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL PROD WATER TREATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TOTAL OPERATING COST, MM$	0.10	0.09	0.09	0.08	0.08
ANNUAL NET OPERATING INCOME, MM$	0.89	0.84	0.80	0.76	0.73
CUM NET OPERATING INCOME, MM$	16.67	17.51	18.31	19.07	19.80
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	10.44	11.28	12.08	12.84	13.56
BASE PRICE OF OIL FOR WPT, $/BBL	45.38	48.56	51.96	55.60	59.49
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.04	0.03	0.03	0.03	0.03
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	0.85	0.81	0.77	0.73	0.70
ANNUAL FEDERAL INCOME TAX, MM$	0.39	0.37	0.35	0.34	0.32
ANNUAL AFTER TAX CASH FLOW, MM$	0.46	0.44	0.41	0.39	0.38
CUM CASH FLOW AFTER TAXES, MM$	5.32	5.76	6.17	6.57	6.94

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	16 2026.	17 2027.	18 2028.	19 2029.	20 2030.
ANNUAL OIL PRODUCTION, MSTB	41.88	40.26	38.65	37.26	35.94
ANNUAL GAS PRODUCTION, MMSCF	13.82	13.29	12.75	12.30	11.86
ANNUAL WATER PRODUCTION, MSTB	385.	387.	389.	390.	392.
OIL PRODUCTION RATE, STB/D	115.	110.	106.	102.	98.
GAS PRODUCTION RATE, MSCF/D	38.	36.	35.	34.	32.
WATER PRODUCTION RATE, STB/D	1054.	1059.	1065.	1069.	1074.
NET OIL SOLD (LESS ROYALTY), MSTB	36.64	35.23	33.82	32.60	31.45
NET GAS SOLD (LESS ROYALTY), MMSCF	12.09	11.63	11.16	10.76	10.38
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	0.84	0.81	0.77	0.75	0.72
ANNUAL GROSS GAS SALES, MM$	0.05	0.04	0.04	0.04	0.04
ANNUAL TOTAL GROSS SALES, MM$	0.88	0.85	0.82	0.79	0.76
ANNUAL ROYALTY, MM$	0.11	0.11	0.10	0.10	0.09
ANNUAL NET SALES, MM$	0.77	0.74	0.71	0.69	0.66
ANNUAL SEVERANCE TAX, MM$	0.06	0.06	0.06	0.06	0.05
ANNUAL FIXED OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL PROD WATER TREATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TOTAL OPERATING COST, MM$	0.08	0.08	0.07	0.07	0.07
ANNUAL NET OPERATING INCOME, MM$	0.69	0.67	0.64	0.62	0.59
CUM NET OPERATING INCOME, MM$	20.49	21.16	21.80	22.42	23.01
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	14.26	14.93	15.57	16.18	16.78
BASE PRICE OF OIL FOR WPT, $/BBL	63.65	68.11	72.87	77.98	83.43
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.03	0.03	0.03	0.02	0.02
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	0.67	0.64	0.61	0.59	0.57
ANNUAL FEDERAL INCOME TAX, MM$	0.31	0.29	0.28	0.27	0.26
ANNUAL AFTER TAX CASH FLOW, MM$	0.36	0.35	0.33	0.32	0.31
CUM CASH FLOW AFTER TAXES, MM$	7.30	7.65	7.98	8.30	8.61

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	21 2031.	22 2032.	23 2033.	24 2034.	25 2035.
ANNUAL OIL PRODUCTION, MSTB	34.89	33.78	32.74	31.89	30.77
ANNUAL GAS PRODUCTION, MMSCF	11.51	11.15	10.80	10.53	10.16
ANNUAL WATER PRODUCTION, MSTB	394.	395.	396.	398.	399.
OIL PRODUCTION RATE, STB/D	96.	93.	90.	87.	84.
GAS PRODUCTION RATE, MSCF/D	32.	31.	30.	29.	28.
WATER PRODUCTION RATE, STB/D	1079.	1082.	1086.	1090.	1093.
NET OIL SOLD (LESS ROYALTY), MSTB	30.53	29.56	28.65	27.91	26.93
NET GAS SOLD (LESS ROYALTY), MMSCF	10.07	9.75	9.45	9.21	8.89
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	0.70	0.68	0.65	0.64	0.62
ANNUAL GROSS GAS SALES, MM$	0.04	0.04	0.04	0.04	0.03
ANNUAL TOTAL GROSS SALES, MM$	0.74	0.71	0.69	0.67	0.65
ANNUAL ROYALTY, MM$	0.09	0.09	0.09	0.08	0.08
ANNUAL NET SALES, MM$	0.64	0.62	0.60	0.59	0.57
ANNUAL SEVERANCE TAX, MM$	0.05	0.05	0.05	0.05	0.05
ANNUAL FIXED OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL PROD WATER TREATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TOTAL OPERATING COST, MM$	0.07	0.07	0.06	0.06	0.06
ANNUAL NET OPERATING INCOME, MM$	0.58	0.56	0.54	0.53	0.51
CUM NET OPERATING INCOME, MM$	23.59	54.15	24.69	25.21	25.72
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	17.35	17.91	18.45	18.98	19.48
BASE PRICE OF OIL FOR WPT, $/BBL	89.27	95.52	102.21	109.36	117.02
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.02	0.02	0.025	0.02	0.02
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	0.55	0.54	0.52	0.50	0.49
ANNUAL FEDERAL INCOME TAX, MM$	0.25	0.25	0.24	0.23	0.22
ANNUAL AFTER TAX CASH FLOW, MM$	0.30	0.29	0.28	0.27	0.26
CUM CASH FLOW AFTER TAXES, MM$	8.91	9.20	9.48	9.75	10.01

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	26 2036.	27 2037.	28 2038.	29 2039.	30 2040.
ANNUAL OIL PRODUCTION, MSTB	29.98	29.14	28.40	27.59	26.85
ANNUAL GAS PRODUCTION, MMSCF	9.89	9.62	9.37	9.11	8.86
ANNUAL WATER PRODUCTION, MSTB	400.	401.	402.	404.	404.
OIL PRODUCTION RATE, STB/D	82.	80.	78.	76.	74.
GAS PRODUCTION RATE, MSCF/D	27.	26.	26.	25.	24.
WATER PRODUCTION RATE, STB/D	1095.	1100.	1103.	1106.	1108.
NET OIL SOLD (LESS ROYALTY), MSTB	26.23	25.50	24.85	24.15	23.49
NET GAS SOLD (LESS ROYALTY), MMSCF	8.66	8.41	8.20	7.97	7.75
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	0.60	0.58	0.57	0.55	0.54
ANNUAL GROSS GAS SALES, MM$	0.03	0.03	0.03	0.03	0.03
ANNUAL TOTAL GROSS SALES, MM$	0.63	0.61	0.60	0.58	0.57
ANNUAL ROYALTY, MM$	0.08	0.08	0.07	0.07	0.07
ANNUAL NET SALES, MM$	0.55	0.54	0.52	0.51	0.50
ANNUAL SEVERANCE TAX, MM$	0.04	0.04	0.04	0.04	0.04
ANNUAL FIXED OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL PROD WATER TREATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TOTAL OPERATING COST, MM$	0.06	0.06	0.06	0.06	0.06
ANNUAL NET OPERATING INCOME, MM$	0.49	0.48	0.47	0.45	0.44
CUM NET OPERATING INCOME, MM$	26.21	26.69	27.15	27.61	28.05
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	19.98	20.46	20.92	21.37	21.81
BASE PRICE OF OIL FOR WPT, $/BBL	125.21	133.98	143.35	153.39	164.13
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.02	0.02	0.02	0.02	0.02
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	0.47	0.46	0.45	0.43	0.42
ANNUAL FEDERAL INCOME TAX, MM$	0.22	0.21	0.21	0.20	0.19
ANNUAL AFTER TAX CASH FLOW, MM$	0.26	0.25	0.24	0.23	0.23
CUM CASH FLOW AFTER TAXES, MM$	10.27	10.51	10.76	10.99	11.22

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	31 2041.	32 2042.	33 2043.	34 2044.	35 2045.
ANNUAL OIL PRODUCTION, MSTB	26.00	25.24	24.52	23.80	23.12
ANNUAL GAS PRODUCTION, MMSCF	8.58	8.33	8.09	7.85	7.63
ANNUAL WATER PRODUCTION, MSTB	405.	406.	407.	408.	409.
OIL PRODUCTION RATE, STB/D	71.	69.	67.	65.	63.
GAS PRODUCTION RATE, MSCF/D	24.	23.	22.	22.	21.
WATER PRODUCTION RATE, STB/D	1110.	1113.	1116.	1118.	1121.
NET OIL SOLD (LESS ROYALTY), MSTB	22.75	22.08	21.46	20.82	20.23
NET GAS SOLD (LESS ROYALTY), MMSCF	7.51	7.29	7.08	6.87	6.68
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	0.52	0.50	0.49	0.48	0.46
ANNUAL GROSS GAS SALES, MM$	0.03	0.03	0.03	0.03	0.03
ANNUAL TOTAL GROSS SALES, MM$	0.55	0.53	0.52	0.50	0.49
ANNUAL ROYALTY, MM$	0.07	0.07	0.06	0.06	0.06
ANNUAL NET SALES, MM$	0.48	0.47	0.45	0.44	0.43
ANNUAL SEVERANCE TAX, MM$	0.04	0.04	0.04	0.04	0.03
ANNUAL FIXED OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL PROD WATER TREATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TOTAL OPERATING COST, MM$	0.05	0.05	0.05	0.05	0.05
ANNUAL NET OPERATING INCOME, MM$	0.43	0.41	0.40	0.39	0.38
CUM NET OPERATING INCOME, MM$	28.47	28.89	29.29	29.67	30.05
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	22.24	22.65	23.05	23.44	23.82
BASE PRICE OF OIL FOR WPT, $/BBL	175.61	187.91	201.06	215.14	230.20
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.02	0.02	0.02	0.02	0.02
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	0.41	0.40	0.38	0.37	0.36
ANNUAL FEDERAL INCOME TAX, MM$	0.19	0.18	0.18	0.17	0.17
ANNUAL AFTER TAX CASH FLOW, MM$	0.22	0.21	0.21	0.20	0.20
CUM CASH FLOW AFTER TAXES, MM$	11.44	11.65	11.86	12.06	12.26

PROJECT ECONOMIC ANALYSIS

UNDISCOUNTED MEAN VALUES

YEAR ENDING	36 2046.	37 2047.	38 2048.	39 2049.	40 2050.
ANNUAL OIL PRODUCTION, MSTB	22.54	21.86	21.27	20.83	20.29
ANNUAL GAS PRODUCTION, MMSCF	7.44	7.21	7.02	6.88	6.70
ANNUAL WATER PRODUCTION, MSTB	410.	411.	411.	412.	412.
OIL PRODUCTION RATE, STB/D	62.	60.	58.	57.	56.
GAS PRODUCTION RATE, MSCF/D	20.	20.	19.	19.	18.
WATER PRODUCTION RATE, STB/D	1123.	1125.	1127.	1128.	1130.
NET OIL SOLD (LESS ROYALTY), MSTB	19.72	19.13	18.61	18.23	17.76
NET GAS SOLD (LESS ROYALTY), MMSCF	6.51	6.31	6.14	6.02	5.86
MEAN PRICE OF OIL, $/BBL	20.00	20.00	20.00	20.00	20.00
MEAN PRICE OF GAS, $/MCF	3.33	3.33	3.33	3.33	3.33
ANNUAL GROSS OIL SALES, MM$	0.45	0.44	0.43	0.42	0.41
ANNUAL GROSS GAS SALES, MM$	0.02	0.02	0.02	0.02	0.02
ANNUAL TOTAL GROSS SALES, MM$	0.48	0.46	0.45	0.44	0.43
ANNUAL ROYALTY, MM$	0.06	0.06	0.06	0.05	0.05
ANNUAL NET SALES, MM$	0.42	0.40	0.39	0.38	0.37
ANNUAL SEVERANCE TAX, MM$	0.03	0.03	0.03	0.03	0.03
ANNUAL FIXED OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL VARIABLE OPERATING COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL WELL WORKOVER COST, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL PROD WATER TREATING COST, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL OVERHEAD, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TOTAL OPERATING COST, MM$	0.05	0.05	0.05	0.05	0.05
ANNUAL NET OPERATING INCOME, MM$	0.37	0.36	0.35	0.34	0.33
CUM NET OPERATING INCOME, MM$	30.42	30.77	31.12	31.46	31.78
ANNUAL WORKING CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL TANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INTANGIBLE CAPITAL, MM$	0.00	0.00	0.00	0.00	0.00
CUM CASH FLOW BEFORE TAXES, MM$	24.18	24.54	24.88	25.22	25.55
BASE PRICE OF OIL FOR WPT, $/BBL	246.31	263.55	282.00	301.74	322.86
ANNUAL WINDFALL PRICE DIFF, $/BBL	0.00	0.00	0.00	0.00	0.00
ANNUAL WINDFALL EXCISE TAX, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL STATE INCOME TAX, MM$	0.01	0.01	0.01	0.01	0.01
ANNUAL INTANGIBLES AND DEPR, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL INVESTMENT TAX CREDIT, MM$	0.00	0.00	0.00	0.00	0.00
ANNUAL NET TAXABLE INCOME, MM$	0.35	0.34	0.33	0.32	0.32
ANNUAL FEDERAL INCOME TAX, MM$	0.16	0.16	0.15	0.15	0.15
ANNUAL AFTER TAX CASH FLOW, MM$	0.19	0.18	0.18	0.18	0.17
CUM CASH FLOW AFTER TAXES, MM$	12.45	12.63	12.81	12.99	13.16

UNDISCOUNTED MEAN RESULTS

PROJECT ECONOMIC LIFE	40.0	YEARS
TOTAL GROSS SALES	40.688	MM$
TOTAL NET SALES	35.602	MM$
TOTAL SEVERANCE TAX	2.848	MM$
TOTAL FIXED OPERATING COST	0.000	MM$
TOTAL VARIABLE OPERATING COST	0.096	MM$
TOTAL WELL WORKOVER COST	0.000	MM$
TOTAL PROD WATER TREATING COST	0.452	MM$
TOTAL OVERHEAD	0.421	MM$
TOTAL OPERATING COST	3.818	MM$
TOTAL WORKING CAPITAL	0.000	MM$
TOTAL TANGIBLE CAPITAL	0.453	MM$
TOTAL INTANGIBLE CAPITAL	5.780	MM$
TOTAL CAPITAL INVESTMENT	6.233	MM$
TOTAL DEBT INTEREST EXPENSE	0.000	MM$
TOTAL PROJECT EXPENSE	10.052	MM$

TOTAL CASH FLOW BEFORE TAX	25.550	MM$
TOTAL WINDFALL PROFITS TAX	0.000	MM$
TOTAL STATE INCOME TAX	1.251	MM$
TOTAL FEDERAL INCOME TAX	11.123	MM$
TOTAL AFTER TAX CASH FLOW	13.156	MM$
TOTAL LOAN AMOUNT	0.000	MM$

PROJECT ECONOMIC ANALYSIS

		PRESNT VALUE	MEAN VALUE CASH FLOW					
			BEFORE TAX (MM$)			AFTER TAX (MM$)		
	YEAR	FACTOR	ANNUAL	CONST $	DISCNTD	ANNUAL	CONST $	DISCNTD
1	2011.	1.0000	-3.76	-3.76	-3.76	-2.21	-2.21	-2.21
2	2012.	0.8658	-1.23	-1.35	-1.57	-0.85	-0.91	-1.03
3	2013.	0.7496	0.79	0.48	-0.06	0.24	0.07	-0.22
4	2014.	0.6490	2.50	1.96	1.06	1.17	0.87	0.39
5	2015.	0.5619	3.99	3.18	1.89	1.98	1.54	0.84
6	2016.	0.4865	5.31	4.22	2.53	2.66	2.08	1.17
7	2017.	0.4212	6.50	5.11	3.03	3.28	2.54	1.43
8	2018.	0.3647	7.59	5.88	3.43	3.85	2.94	1.64
9	2019.	0.3158	8.60	6.57	3.75	4.37	3.30	1.81
10	2020.	0.2734	9.55	7.17	4.01	4.86	3.61	1.94
11	2021.	0.2367	10.44	7.72	4.22	5.32	3.89	2.05
12	2022.	0.2049	11.28	8.21	4.39	5.76	4.15	2.14
13	2023.	0.1774	12.08	8.66	4.54	6.17	4.38	2.21
14	2024.	0.1536	12.84	9.06	4.65	6.57	4.59	2.27
15	2025.	0.1330	13.56	9.43	4.75	6.94	4.78	2.32
16	2026.	0.1152	14.26	9.76	4.83	7.30	4.95	2.37
17	2027.	0.0997	14.93	10.07	4.90	7.65	5.11	2.40
18	2028.	0.0863	15.57	10.35	4.95	7.98	5.26	2.43
19	2029.	0.0747	16.18	10.60	5.00	8.30	5.39	2.45
20	2030.	0.0647	16.78	10.84	5.04	8.61	5.51	2.47
21	2031.	0.0560	17.35	11.06	5.07	8.91	5.62	2.49
22	2032.	0.0485	17.91	11.26	5.09	9.20	5.73	2.50
23	2033.	0.0420	18.45	11.44	5.12	9.48	5.82	2.51
24	2034.	0.0364	18.98	11.61	5.14	9.75	5.91	2.52
25	2035.	0.0315	19.48	11.77	5.15	10.01	5.99	2.53
26	2036.	0.0273	19.98	11.92	5.17	10.27	6.07	2.54
27	2037.	0.0236	20.46	12.05	5.18	10.51	6.14	2.55
28	2038.	0.0204	20.92	12.17	5.19	10.76	6.20	2.55
29	2039.	0.0177	21.37	12.29	5.19	10.99	6.26	2.55
30	2040.	0.0153	21.81	12.40	5.20	11.22	6.32	2.56
31	2041.	0.0133	22.24	12.50	5.21	11.44	6.37	2.56
32	2042.	0.0115	22.65	12.59	5.21	11.65	6.42	2.56
33	2043.	0.0099	23.05	12.67	5.22	11.86	6.46	2.57
34	2044.	0.0086	23.44	12.75	5.22	12.06	6.50	2.57
35	2045.	0.0075	23.82	12.82	5.22	12.26	6.54	2.57
36	2046.	0.0065	24.18	12.89	5.22	12.45	6.57	2.57
37	2047.	0.0056	24.54	12.95	5.23	12.63	6.60	2.57
38	2048.	0.0048	24.88	13.00	5.23	12.81	6.63	2.57
39	2049.	0.0042	25.22	13.06	5.23	12.99	6.66	2.57
40	2050.	0.0036	25.55	13.11	5.23	13.16	6.69	2.57

S C I E N T I F I C S O F T W A R E
- I N T E R C O M P

INFILL DRILLING PREDICTION MODEL
(IDPM - RELEASE 1.2.0)

Economics for Infill over Non-Infill

PRODUCTION SUMMARY

PROJECT ECONOMIC LIFE	40.0	YEARS
CUMULATIVE GROSS OIL SOLD	1928.	MSTB
CUMULATIVE GROSS GAS SOLD	636.	MMSCF

CUMULATIVE NET OIL SOLD	1687.	MSTB
PRESENT VALUE OF NET OIL SOLD	613.	MSTB

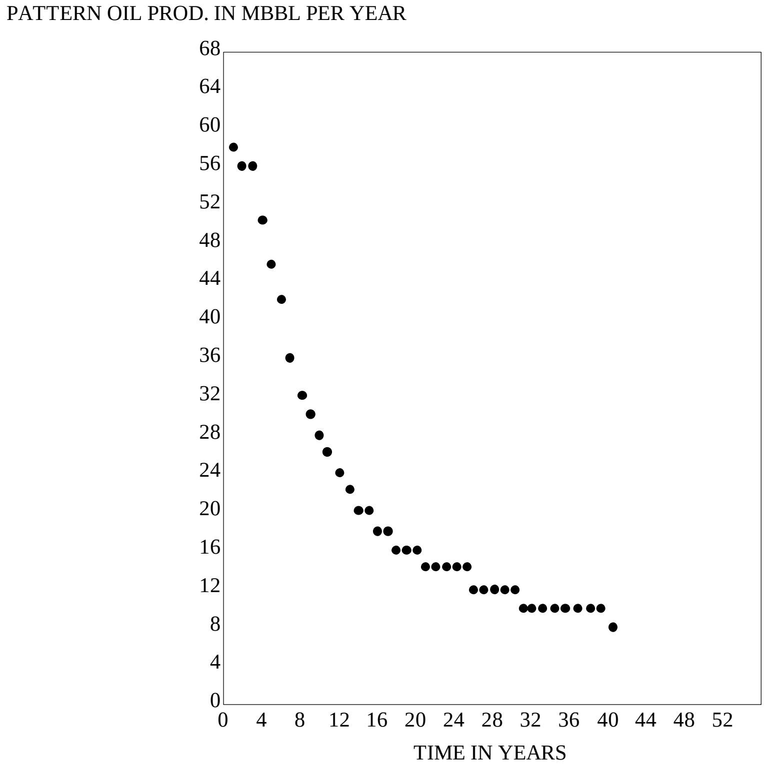
MEAN RESULTS

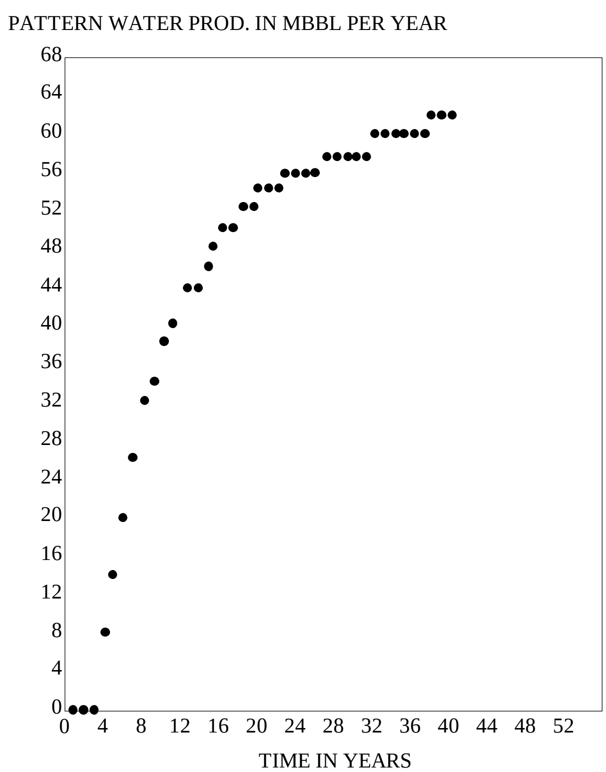
PRESENT VALUE OF TOTAL GROSS SALES	14.786	MM$
PRESENT VALUE OF TOTAL NET SALES	12.938	MM$
TOTAL SEVERANCE TAX (PV)	1.035	MM$
TOTAL FIXED OPERATING COST (PV)	0.000	MM$
TOTAL VARIABLE OPERATING COST (PV)	0.035	MM$
TOTAL WELL WORKOVER COST (PV)	0.000	MM$
TOTAL PROD WATER TREATING COST (PV)	0.071	MM$
TOTAL OVERHEAD (PV)	0.333	MM$
TOTAL OPERATING COST (PV)	1.474	MM$
TOTAL WORKING CAPITAL (PV)	0.000	MM$
TOTAL TANGIBLE CAPITAL INVESTED (PV)	0.453	MM$
TOTAL INTANGIBLE CAPITAL (PV)	5.780	MM$
TOTAL CAPITAL INVESTMENT (PV)	6.233	MM$
TOTAL INTEREST EXPENSE (PV)	0.000	MM$
TOTAL PROJECT EXPENSE (PV)	7.707	MM$
TOTAL LOAN PRINCIPAL REPAYMENT (PV)	0.000	MM$
DISCOUNTED COST PER DISC NET OIL	12.569	$/BBL
DISCOUNTED CASH FLOW BEFORE TAX	5.230	MM$

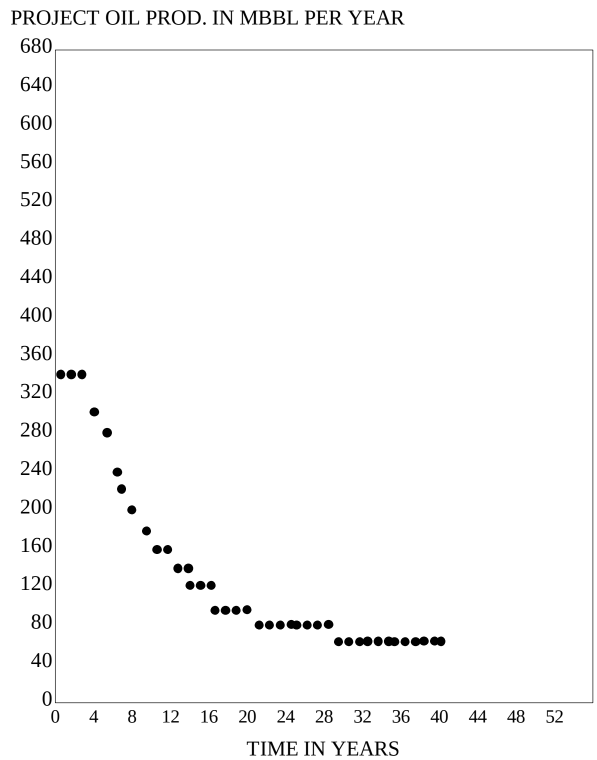
PROJECT PROFITABILITY (AFTER TAX)

AVERAGE MONETARY DISCOUNT RATE	10.00	PCNT
90 PCNT CONFIDENCE DCF	0.518	MM$
MEAN DISCOUNTED CASH FLOW	2.573	MM$
10 PCNT CONFIDENCE DCF	4.982	MM$
STANDARD DEVIATION OF THE MEAN DCF	1.685	MM$
MEAN DCF PROFIT TO INVESTMENT RATIO	0.413	P/I
MEAN DCF PROFIT TO EXPENSE RATIO	0.334	P/E
MEAN DCF PROFIT PER DISC NET OIL	4.196	$/BBL
MEAN INVESTMENT EFFICIENCY	1.573	
MEAN DCF RATE OF RETURN	29.54	PCNT

Economics for Waterflood






PROJECT OIL PROD. IN MBBL PER YEAR
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640
600
560
520
480
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400
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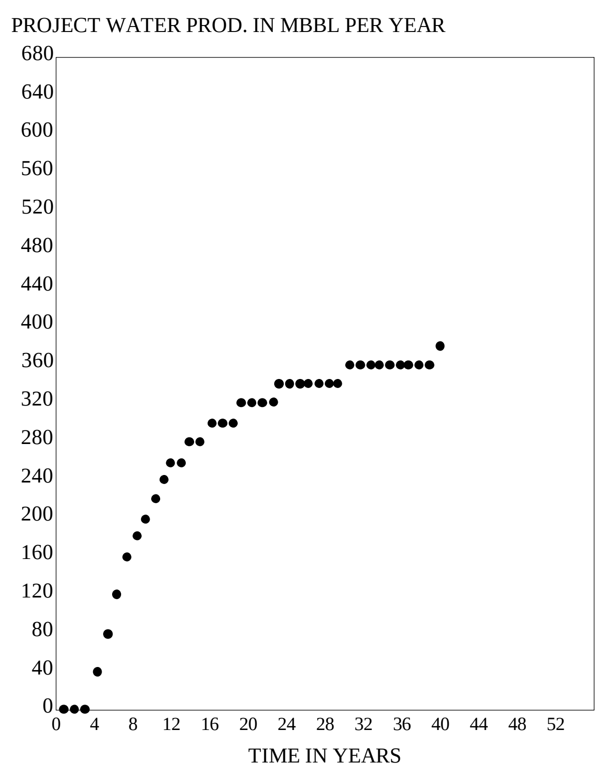
240
200
160
120
80
40
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS


PROJECT WATER PROD. IN MBBL PER YEAR
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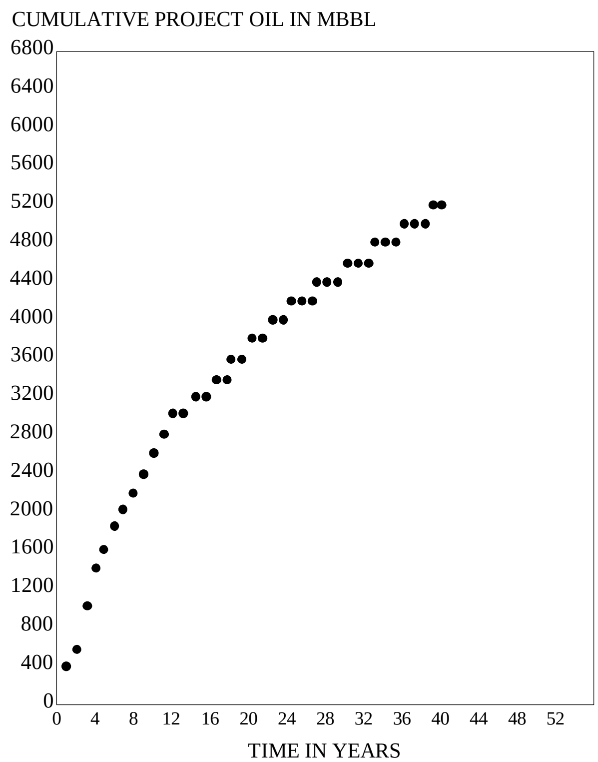
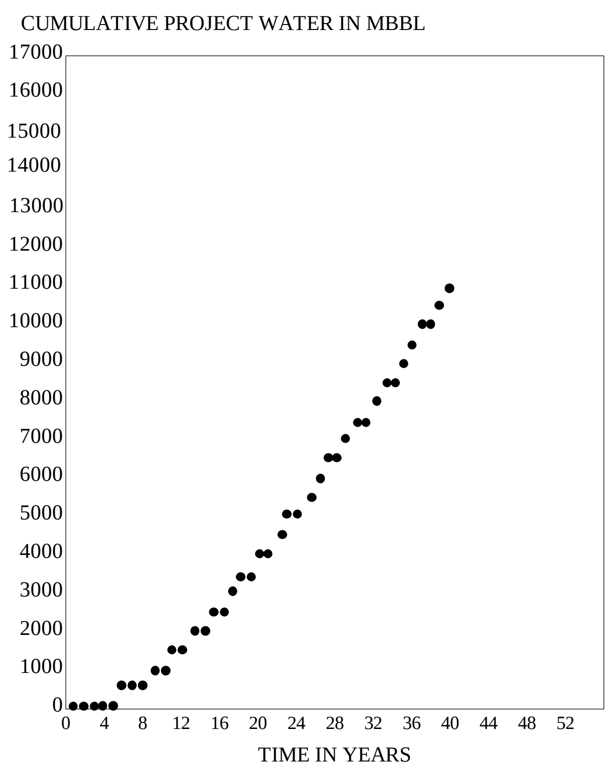
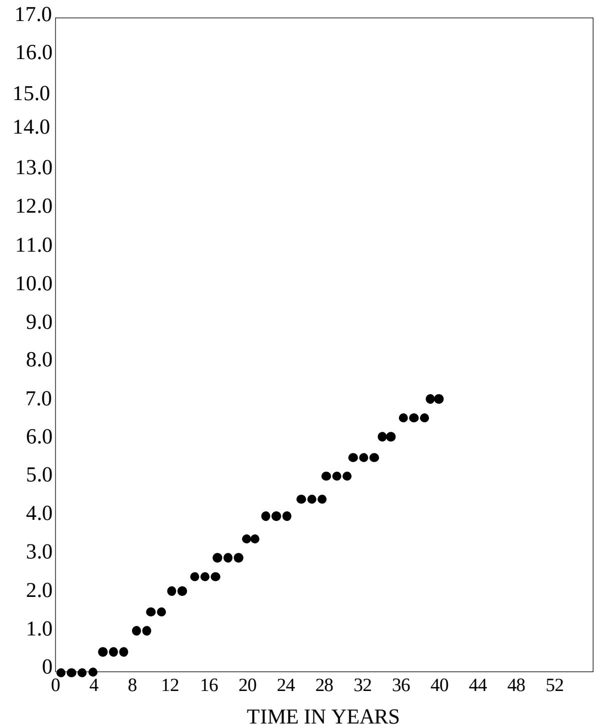
640
600
560
520
480
440
400
360
320
280
240
200
160
120
80
40
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS

Economics for Waterflood

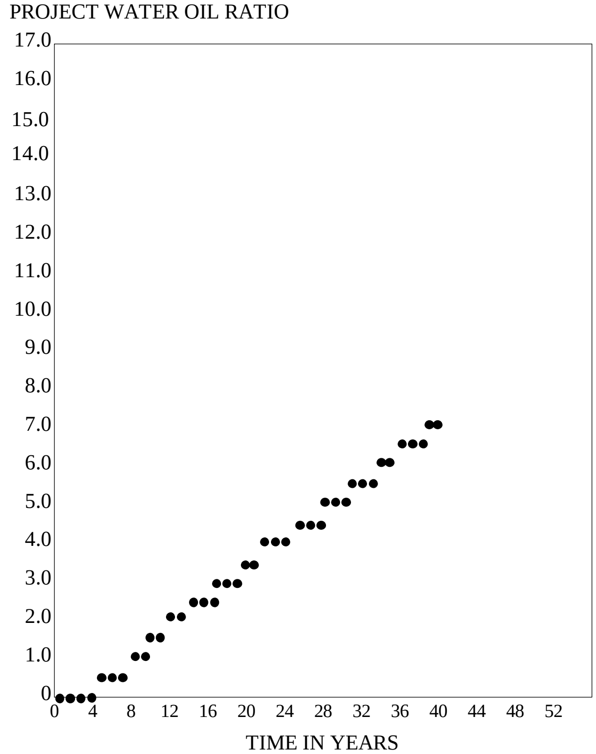


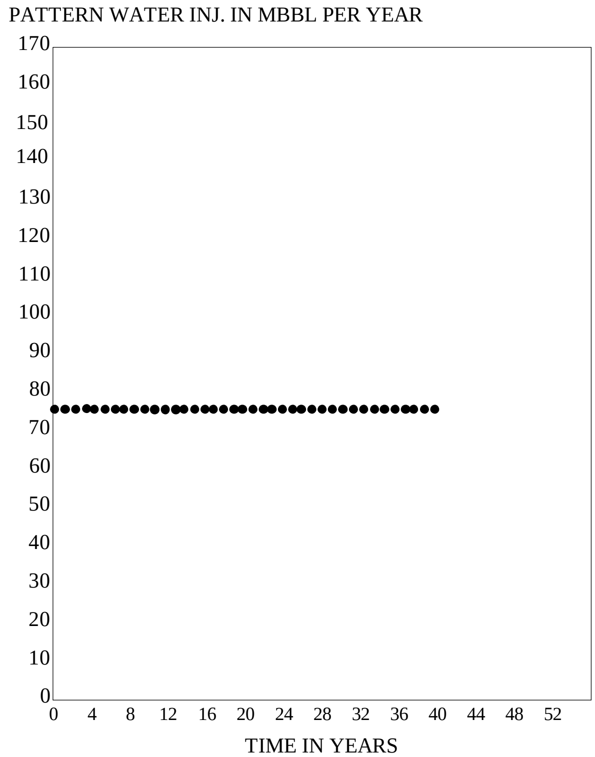


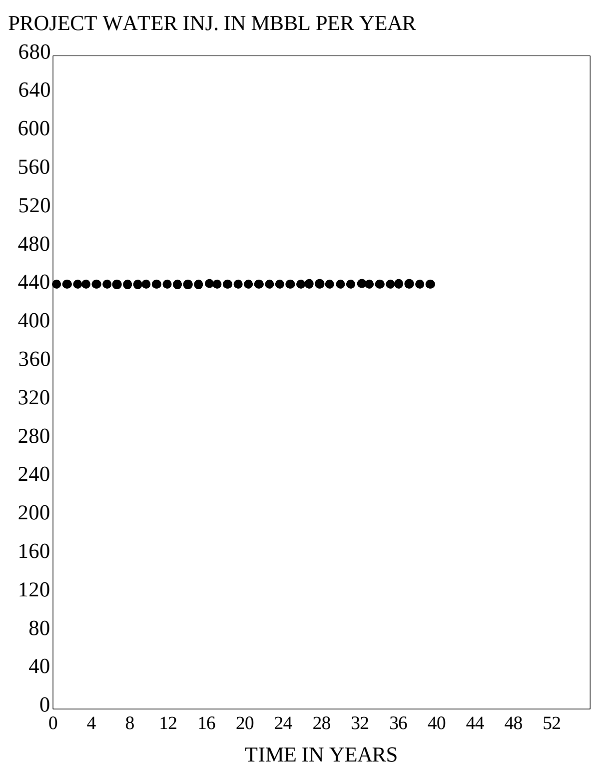
PATTERN WATER OIL RATIO



PROJECT WATER OIL RATIO




PATTERN WATER INJ. IN MBBL PER YEAR
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS


PROJECT WATER INJ. IN MBBL PER YEAR
680
640
600
560
520
480
440
400
360
320
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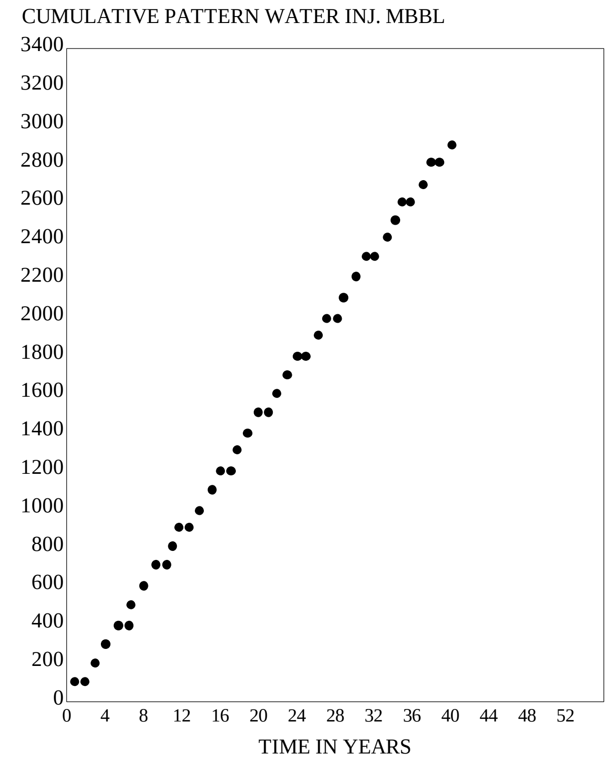
240
200
160
120
80
40
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS


CUMULATIVE PATTERN WATER INJ. MBBL
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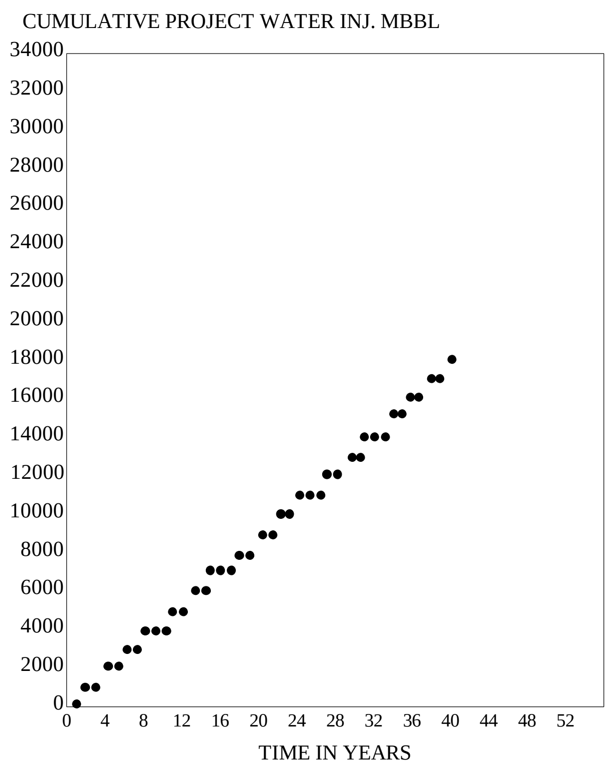
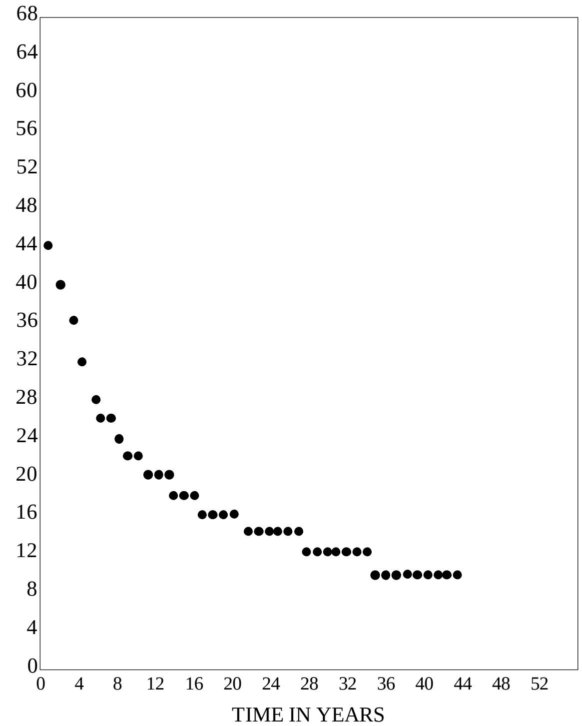
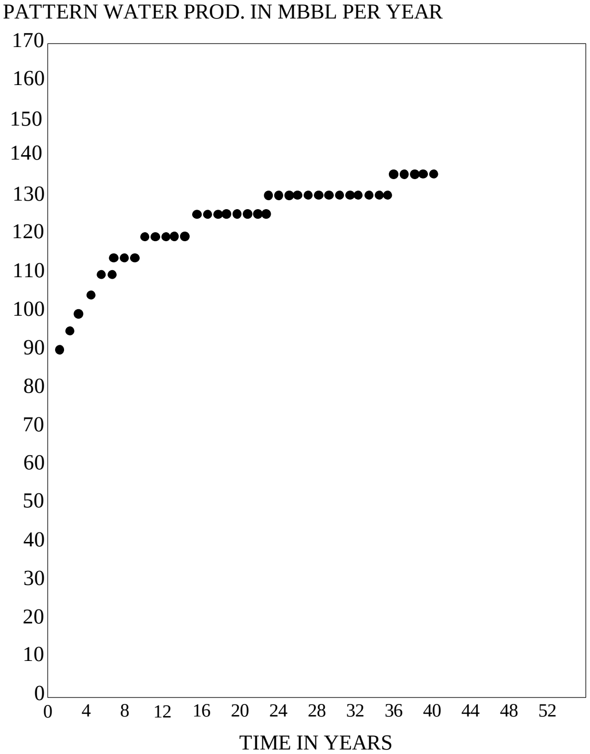
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS

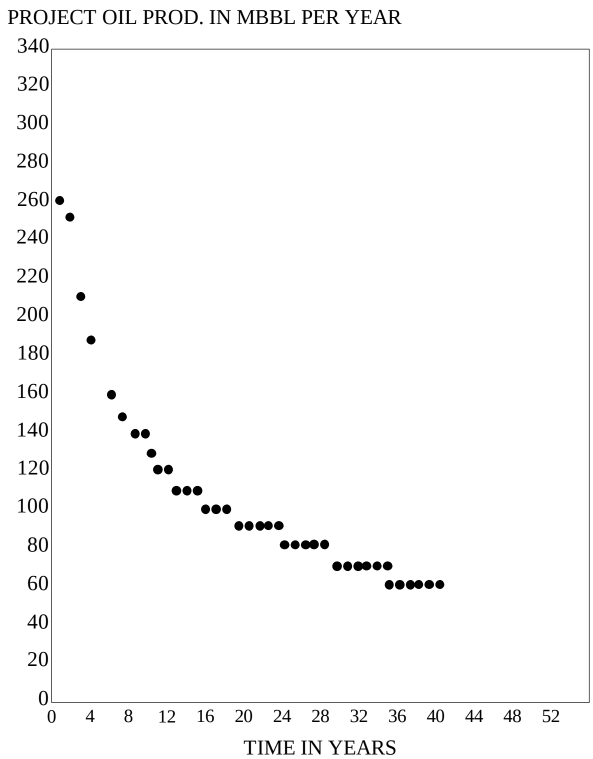

CUMULATIVE PROJECT WATER INJ. MBBL
34000
32000
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS

PATTERN OIL PROD. IN MBBL PER YEAR



PATTERN WATER PROD. IN MBBL PER YEAR




PROJECT OIL PROD. IN MBBL PER YEAR
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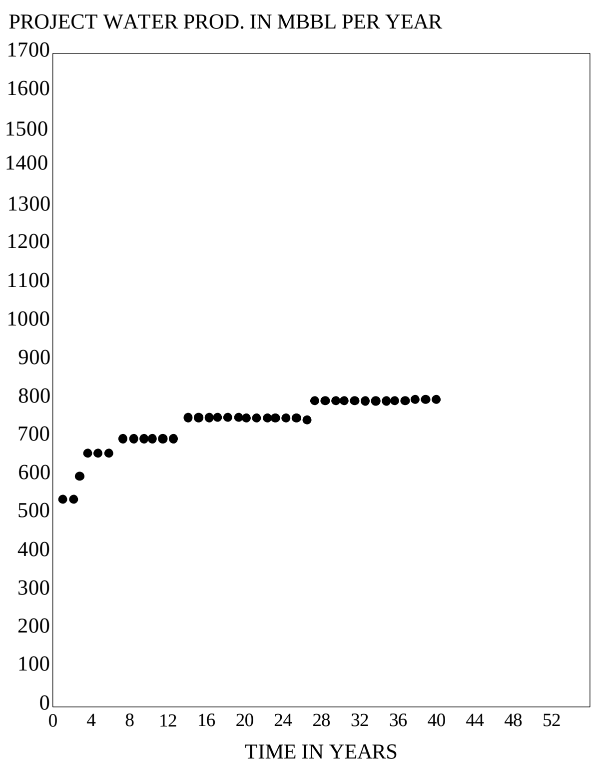
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS


PROJECT WATER PROD. IN MBBL PER YEAR
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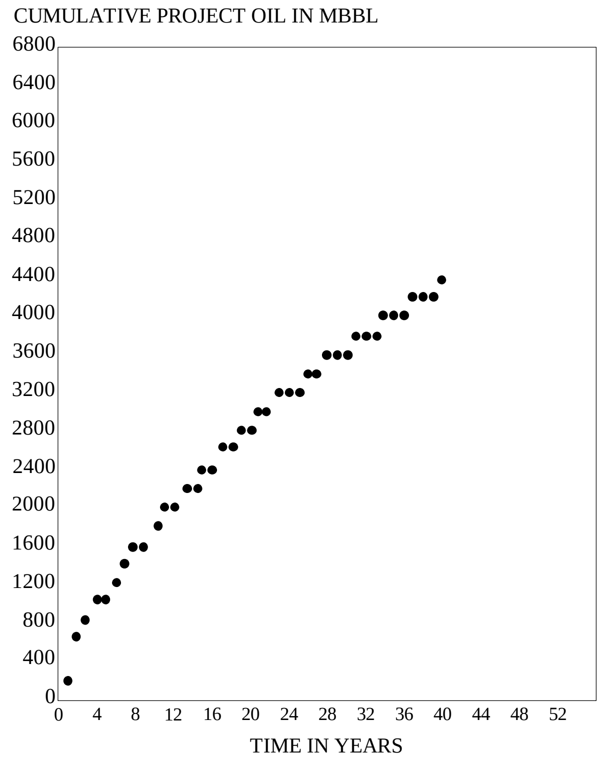
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS


CUMULATIVE PROJECT OIL IN MBBL
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6400
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5600
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4800
4400
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3200
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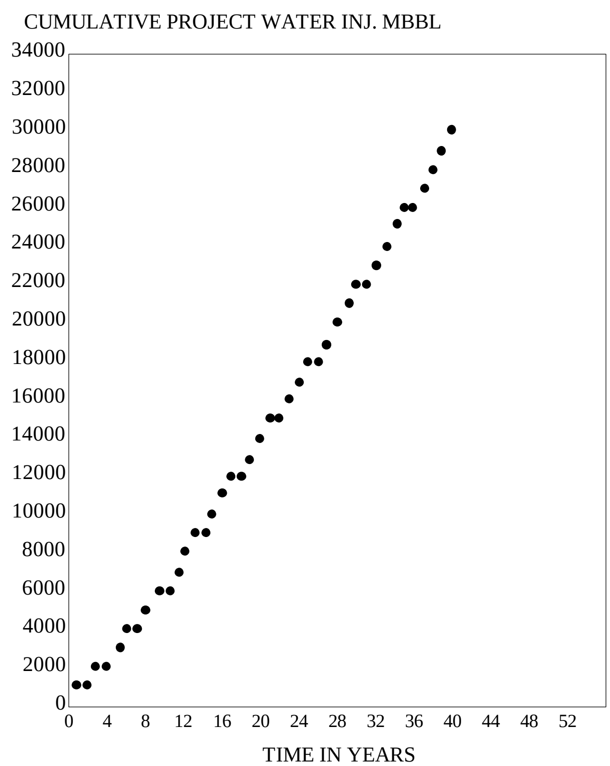
2400
2000
1600
1200
800
400
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS


CUMULATIVE PROJECT WATER INJ. MBBL
34000
32000
30000
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24000
22000
20000
18000
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12000
10000
8000
6000
4000
2000
0
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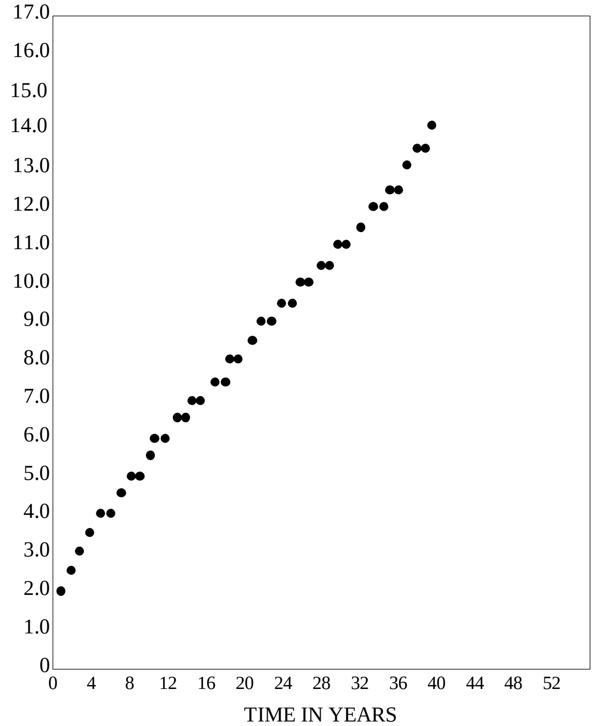
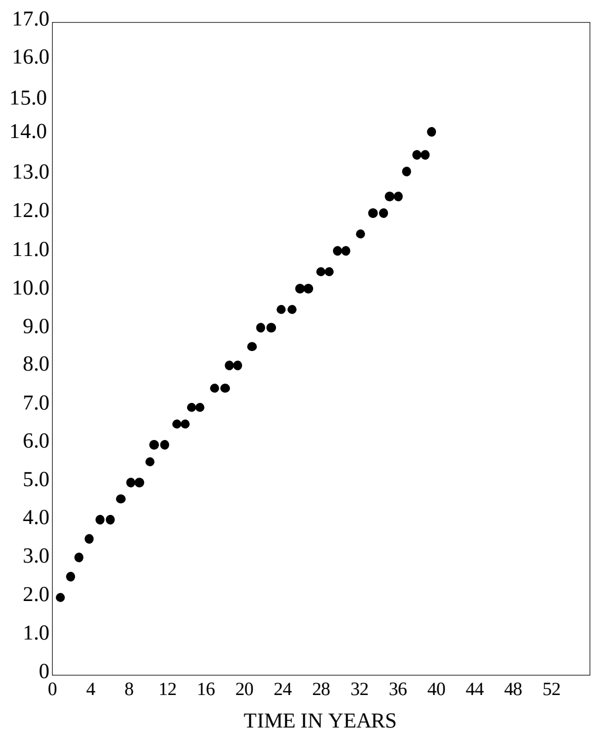
TIME IN YEARS

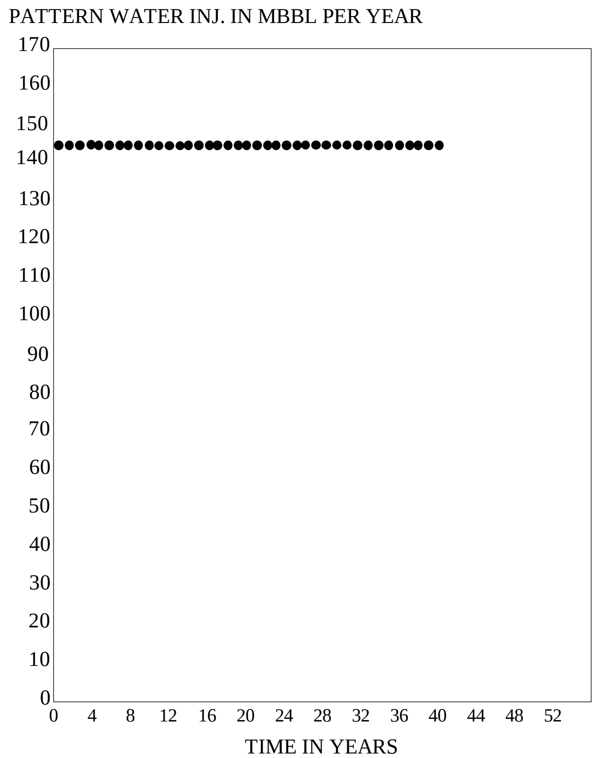
PATTERN WATER OIL RATIO

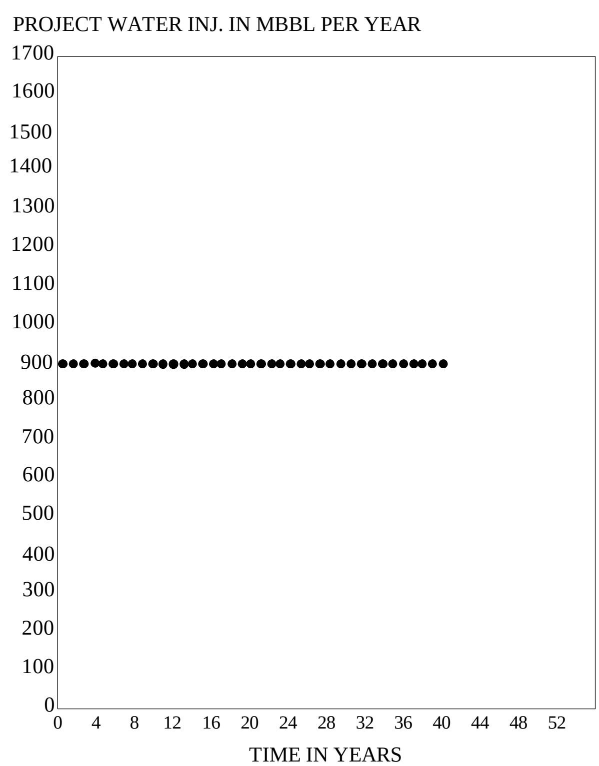


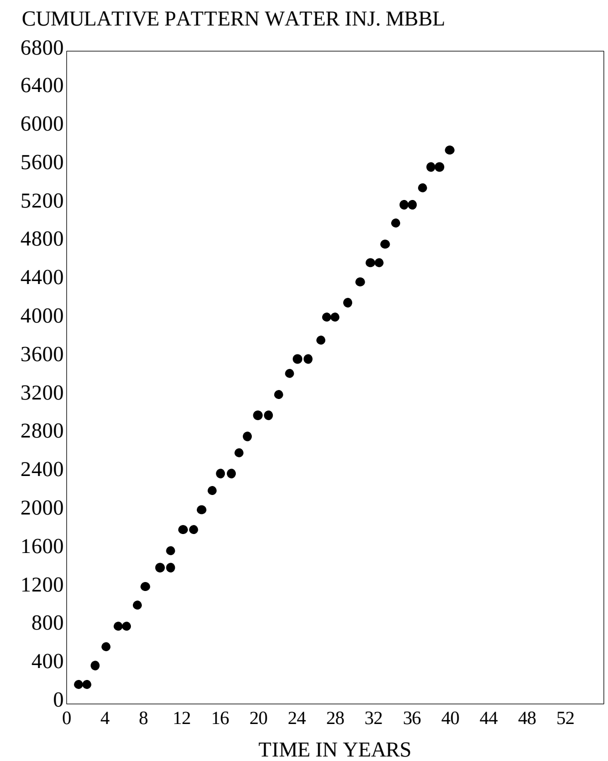
PROJECT WATER OIL RATIO

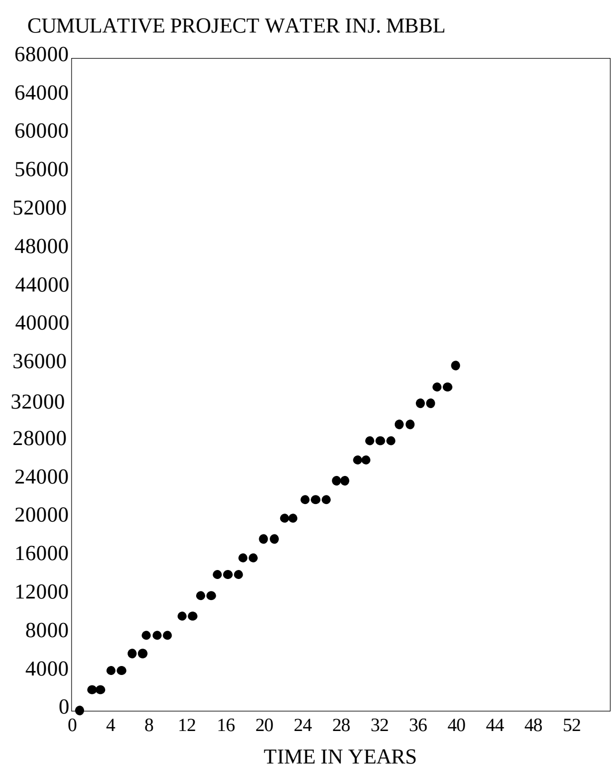


Economics for Infill Waterflood

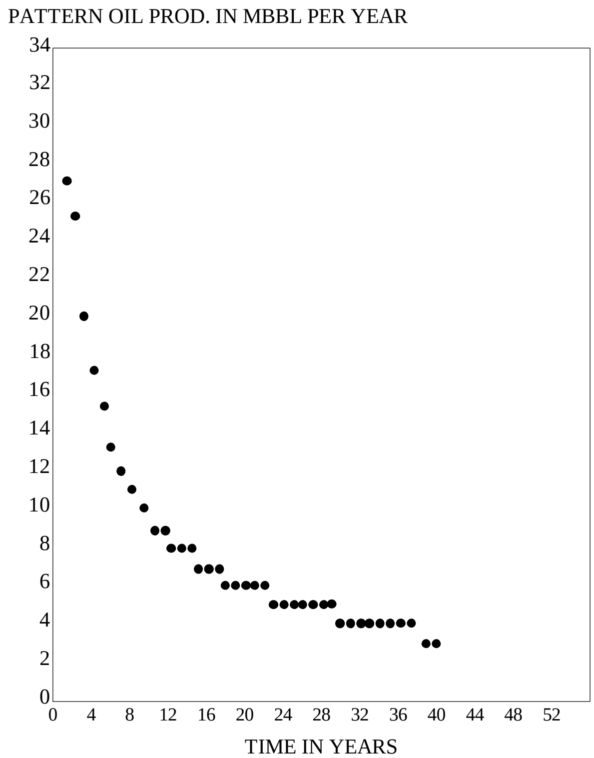


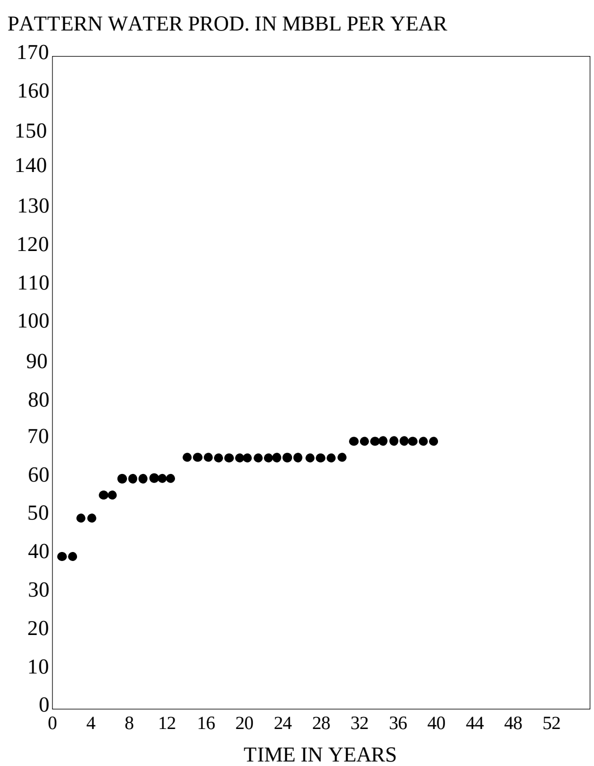



CUMULATIVE PATTERN WATER INJ. MBBL
6800
6400
6000
5600
5200
4800
4400
4000
3600
3200
2800
2400
2000
1600
1200
800
400
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS

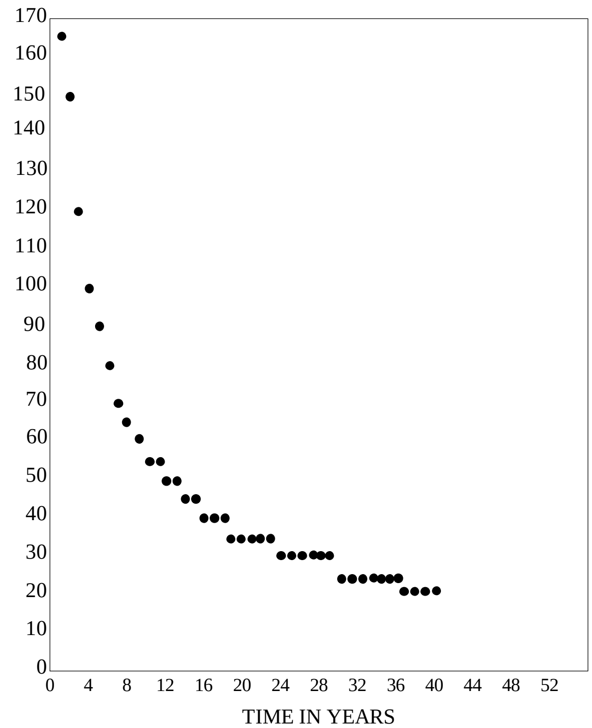

CUMULATIVE PROJECT WATER INJ. MBBL
68000
64000
60000
56000
52000
48000
44000
40000
36000
32000
28000
24000
20000
16000
12000
8000
4000
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS

Economics for Infill over Non-Infill

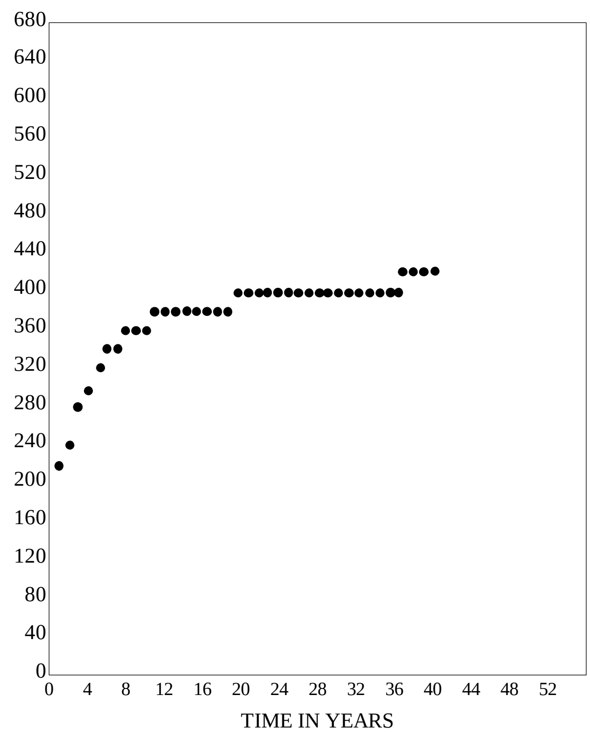


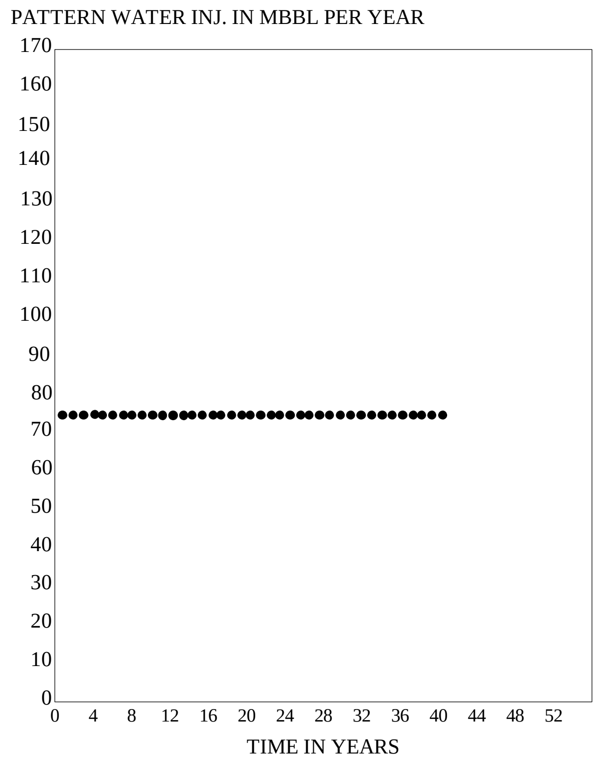


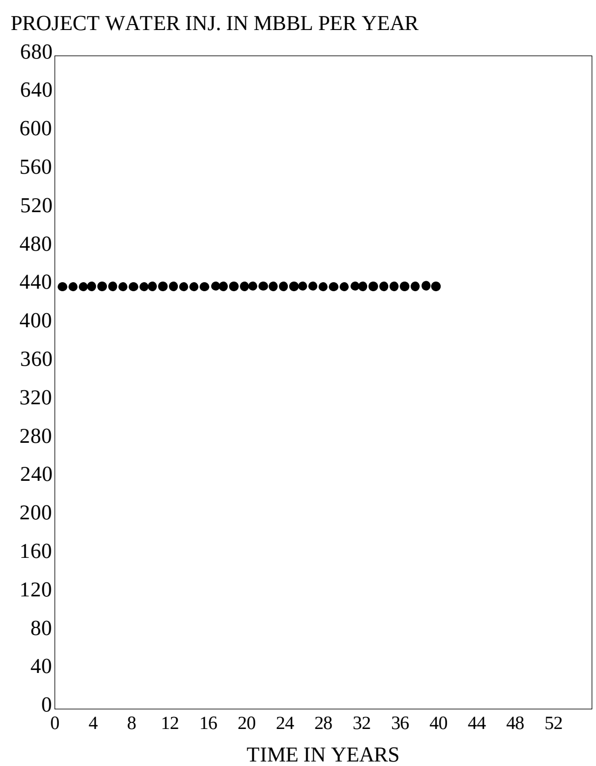
PROJECT OIL PROD. IN MBBL PER YEAR

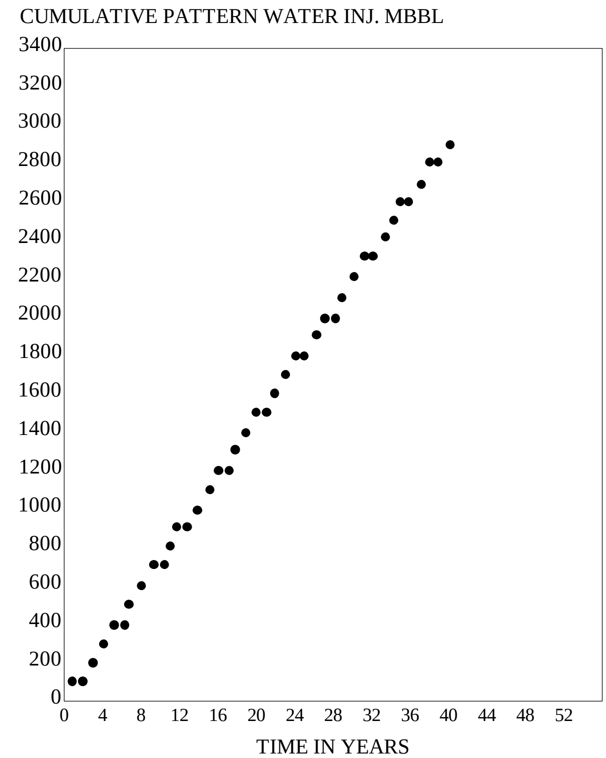


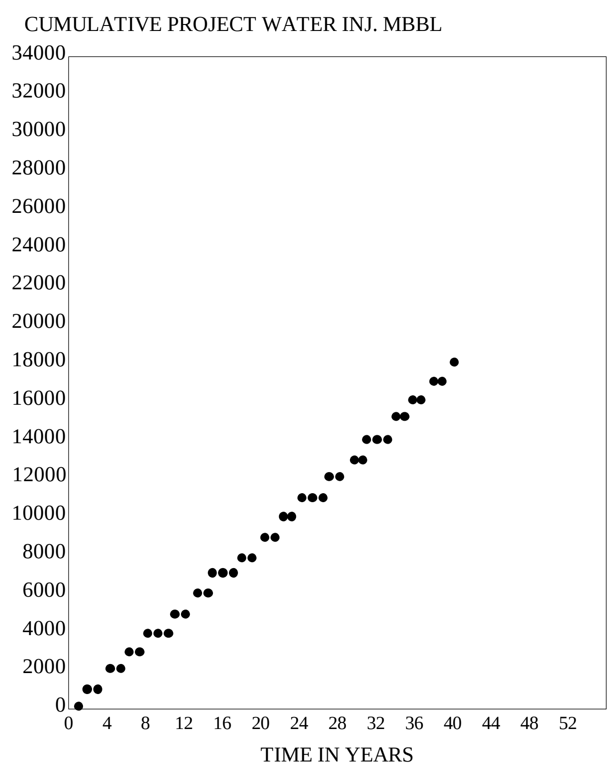
PROJECT WATER PROD. IN MBBL PER YEAR



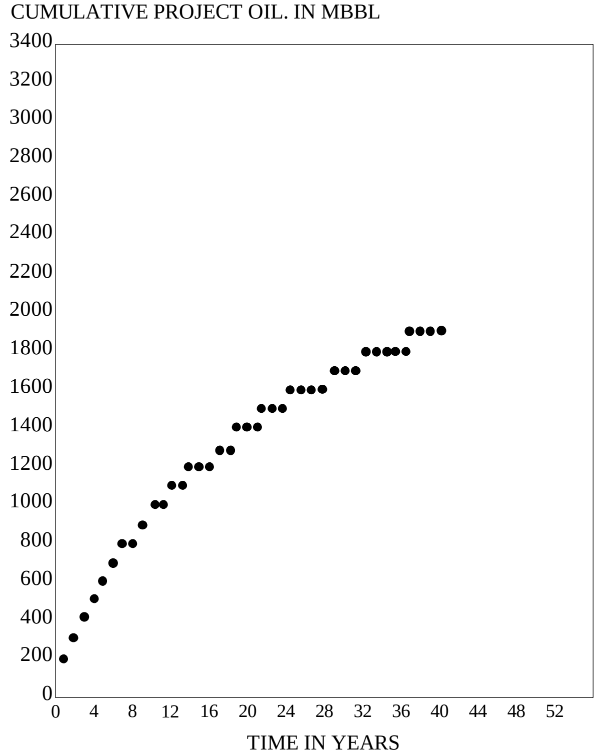

PATTERN WATER INJ. IN MBBL PER YEAR
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS

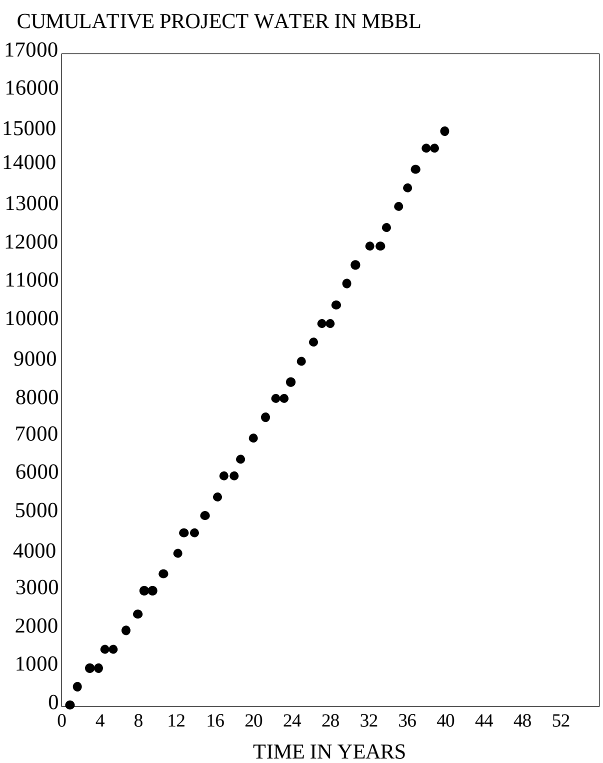

PROJECT WATER INJ. IN MBBL PER YEAR
680
640
600
560
520
480
440
400
360
320
280
240
200
160
120
80
40
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS


CUMULATIVE PATTERN WATER INJ. MBBL
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS

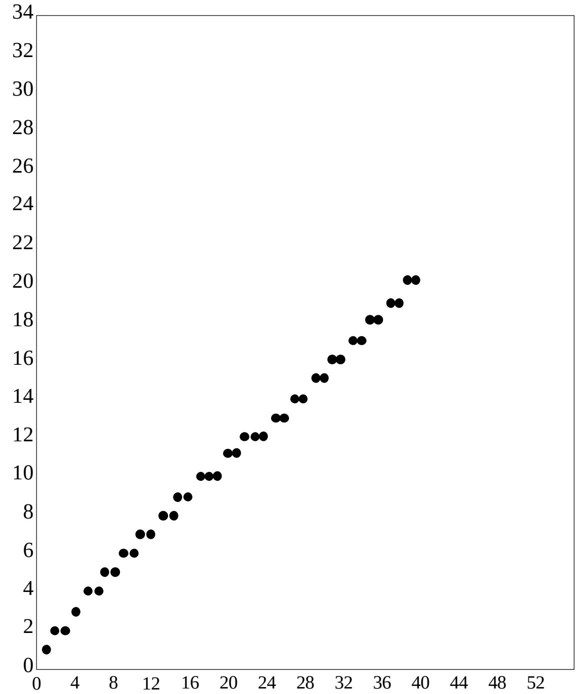

CUMULATIVE PROJECT WATER INJ. MBBL
34000
32000
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0 4 8 12 16 20 24 28 32 36 40 44 48 52
TIME IN YEARS

Economics for Infill over Non-Infill



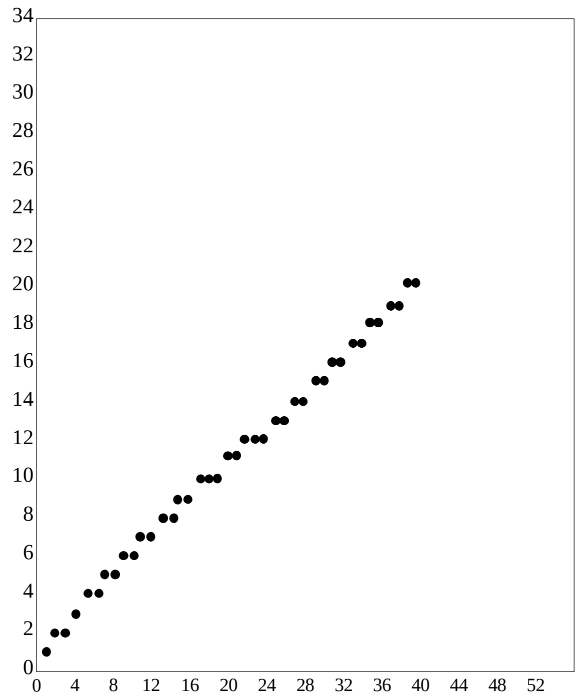


PATTERN WATER OIL RATIO



TIME IN YEARS

PATTERN WATER OIL RATIO



TIME IN YEARS